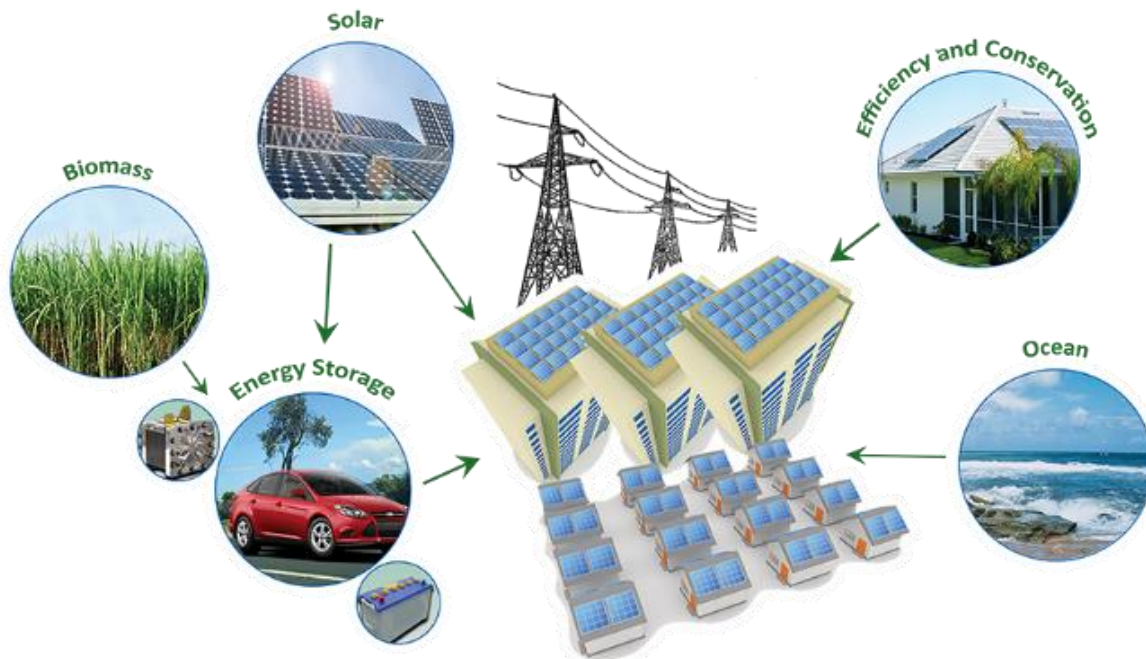




**Florida Energy Systems Consortium  
Semi-Annual Report  
to  
Dr. David Norton, Vice President for Research  
Chair of the Oversight Board**

**May 2016**

**Reporting Period: Oct 1, 2015 – April 30, 2016**



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## EXECUTIVE SUMMARY

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**Overview:** The Florida Energy Systems Consortium administration office worked very closely with the Office of Energy, the FESC Oversight Board, the FESC Steering Committee, and the FESC Industrial Advisory Board to request new recurring research funding from the state. The FESC administration office had several meetings/telecons with the Office of Energy during this reporting period to discuss the budget request and elucidate its positive impacts on the future of our state in the energy area. In addition, FESC administration met several representatives, senators, and staff members to lobby the FESC legislative budget request. FESC Industrial Advisory Board members signed a letter of support that will be emailed to the key legislators in support of FESC funding request. FESC recurring research funding request will go through the legislative session in June, 2015. All 12 University VPRs are in support of this funding request.

The Florida Energy Systems Consortium continues to leverage State funding in energy research, technology transfer, education, and outreach activities. The FESC office facilitates submission of competitive proposals in a variety of ways - by disseminating solicitations, identifying research leaders and building teams to compete in these solicitations, communicating with industry partners, national labs and other non-SUS universities.

The FESC technology transfer program includes business plan/market research development (Phase I) and industry matched funding of early stage development (Phase II). **Thirty two (32) companies have been formed since 2008** based on university developed technologies. The company list with the area of technology is given in [Appendix B](#).

FESC continues to produce results in energy research, technology transfer, education, and outreach activities. The FESC administrative office is successfully facilitating interactions among Florida's energy industry and researchers at FESC universities, Florida's State and Community Colleges, and the Florida Institute of Technology. The FESC office has developed over 1000 faculty/industry contacts. This comprehensive network enables and facilitates the transfer of FESC technologies quickly for maximum benefit to Florida's economy. FESC coordinates research teams to develop and submit a significant number of joint proposals. FESC continues to contribute to energy education and outreach programs. FESC has 14 active projects. The list of these projects is given on page 14 of this report. Nine of these projects are in energy education area. The descriptions and brief progress reports of education projects are given in the "education" section of this report on page 22. The Consortium's outreach team initiated Sustainable Floridian<sup>SM</sup> Program with ARRA funding. The program has been offered in Leon, Marion, Pinellas Osceola, and Sarasota Counties. The program was funded through Office of Energy bridge funds to continue with the development of the program. Their report is given on page 39 of this report.

FESC organized an Energy Workshop on "Integration of Renewable Energy into the Grid" on Feb 2-3, 2015 at the Hyatt Regency Orlando Hotel in Orlando, FL. This instructional workshop was designed for industrial personnel, students and faculty who wanted to learn the state of the art and future directions in enabling renewable energy integration. A total of 114 people were in attendance; 66 university faculty and students, and 48 industry members. Experts in this area presented the workshop lectures. FESC Annual Workshop is scheduled to be on May 20-21, 2015 in Orlando. Ten invited keynote speakers, and 77 speakers (faculty, industry members, and students) will present at the workshop. In addition, there will be 18 student posters. Ben Rowland, Founder of University Proposals, will give a short course on "large scale proposal development" after the workshop. During the workshop, FESC industrial board members will have a dinner meeting.

Three new industrial advisory board members joined the FESC board. The new members are: Thomas (TJ) Szelistowski, Managing Director – Regulatory Affairs, Tampa Electric Company, replacing Greg Ramon, Paul Zambo, Siemens, replacing Frank Bevc, and Bryan Levy, President and CEO of XChanger Companies Inc.

FESC Office established the “**Energy Crop Certification**” faculty workgroup in collaboration with Treasure Coast Research Park to develop a roadmap for a statewide implementation of an Advanced Biofuel Feedstock Certification Program. The primary goal of this program is to make alternate crops available for the farmers that have unusable land due to citrus greening issue.

FESC administration attended 16 conferences and workshops to expand the FESC network by developing new partnerships. The list of the conferences and workshops attended during the reporting period is given on page 17 of this report.

FESC prepares and distributes bi-monthly electronic newsletters by email to over 1000 subscribers. The e-newsletters are published at FESC website: [http://www.floridaenergy.ufl.edu/?page\\_id=1999](http://www.floridaenergy.ufl.edu/?page_id=1999). The printed version of the e-newsletters is given on page 45 in this report.

The Florida Energy Systems Consortium has made significant progress in its research, education, industrial collaboration, and technology commercialization agenda. FESC faculty members statewide are successfully collaborating in research and proposal development.

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## NEW PROGRAM DEVELOPMENT

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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. **82 funding opportunities** were distributed to the FESC faculty during this period. The list of funding opportunities is given in [Appendix 1](#). The funding opportunities are also posted at the FESC web site: [http://www.floridaenergy.ufl.edu/?page\\_id=912](http://www.floridaenergy.ufl.edu/?page_id=912). Faculty teams were formed to respond to the funding opportunities based on the responses received from the faculty. The FESC office facilitates proposal development in a variety of ways beyond solicitation awareness, including identifying leaders, communicating with external partners in industry, national labs and other non-SUS universities, arranging telecons, providing support letters, and finding ways to meet the cost share requirements.

### *Proposal Development Facilitation*

FESC office assisted (or assisting) with team formation (and/or faculty submitted) for the following calls:

- DE-FOA-0001383: Building Energy Efficiency Frontiers and Innovation Technologies (BENEFIT)
- NSF 16-524: Innovations at the Nexus of Food, Energy and Water Systems (INFEWS)
- DE-FOA-0001469: Solid Oxide Fuel Cell Innovative Concepts and Core Technology
- DE-FOA-0001433 - MEGA-BIO: BIOPRODUCTS
- DE-FOA-0001384 - Fiscal Year 2016 Vehicle Technologies Program
- DE-FOA-0001532- Commercial Buildings and Energy Code Field Studies
- DE-FOA-0001540 - Bioenergy Research Centers
- DE-FOA-0001232: Project Development For Pilot and Demonstration Scale Manufacturing of Biofuels, Bioproducts And Biopower (PD2B3)
- USDA-NIFA-AFRI- A6101: Coordinated Agricultural Projects (CAP) Development of Regionally appropriate Biomass Feedstock Systems for Bioenergy, Industrial Chemicals, and Bioproducts

In addition,

- Dr. Albert Boulanger, Columbia University was introduced to Drs. Shuo Wang, Arturo Bretas, Sean Meyn, ECE, UF for potential collaboration.
- Bioenergy team was formed at UF to respond to upcoming bioenergy related calls in collaboration with other FESC universities.
- Grid/Cyber Security team led by Dr. Mark Tehranipoor at UF invited FESC to participate. The team is planning to hold a workshop in the fall. FESC will assist in finding speakers.
- Dr. Rob Gilbert, Chair of Agronomy was briefed about the Energy Crop Certification Road Map and Farm to Fuel programs.

### *Conferences/Meetings Attended*

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

- National Engineering Forum at UCF, Nov 9, 2015
- Sayfie Review Florida Leaders Summit in Orlando, Nov 16-17, 2016
- 22nd Annual Public Interest Environmental Conference at UF, Feb 11-13, 2016. The conference was organized by Levin College of Law. The meeting agenda is posted at: <https://ufpiec.org/>
- 5th University of Florida Water Institute Symposium at UF, Feb 16-17, 2016. The meeting agenda is posted at: <http://waterinstitute.ufl.edu/symposium2016/agenda.html>
- Conflict Management in Interdisciplinary Climate Projects at UF, Feb 29, 2016.

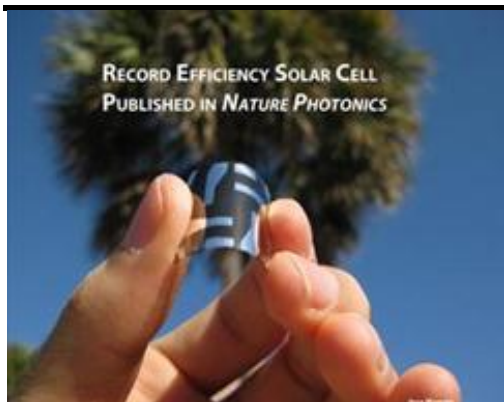
- USDA Feasibility Grant Team meeting at Ft Pierce, Jan 7, 2016
- Florida Chamber Capitol Days in Tallahassee, January 13-15, 2016.
- A Celebration of Innovation Showcase 2016 at UF, March 8, 2016. The agenda is posted at: [http://research.ufl.edu/otl/about-otl/a-celebration-of-innovation-startup-showcase/a-celebration-of-innovation-startup-showcase-agenda.html?mc\\_cid=16183ef7f7&mc\\_eid=043441a469](http://research.ufl.edu/otl/about-otl/a-celebration-of-innovation-startup-showcase/a-celebration-of-innovation-startup-showcase-agenda.html?mc_cid=16183ef7f7&mc_eid=043441a469)
- Power up Defense Energy Forum, March 16-17, 2016. The meeting agenda is posted at: <http://www.gulfcoastenergynetwork.org/events/>. C. Balaban gave a FESC overview presentation at this meeting.

Numerous new contacts were established at these conferences, meetings, and workshops. Some of the contacts were shared with faculty members for potential collaborations.

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### INDUSTRIAL COLLABORATION AND TECHNOLOGY COMMERCIALIZATION

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

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

#### **Companies Contacted and/or Assisted During the Reporting Period**

The companies we are in communication are listed at FESC web site based on area of expertise (under different sub menus): [http://www.floridaenergy.ufl.edu/?page\\_id=11727](http://www.floridaenergy.ufl.edu/?page_id=11727)

Companies/organizations contacted and/or assisted during the reporting period include:

- Eco Smart: Discussed Demand Side response project and FESC activities in this area. Introduced their Energizr-200 energy storage products (grid applications) Requested FPL contacts. Introduced him to FPL.
- Doosan: Introduced them to UF Faculty, UF IPPD, and UF PPD. Follow up meetings were held.
- RES Polyflow: Looking for a new location to move to FL. Working with Gainesville Chamber to attract them Gainesville location. Discussions/meeting are continuing.
- Mainstream Engineering: Multiple conversations regarding UF/UNF project, their I-Beam facility and UF fellowship to support this activity. Shared multiple funding opportunities for potential collaboration.
- IBM: Discussed their cloud based software and applications to grid projects.
- Appollidon: Discussed their on-line education capabilities and FESC education program.
- Power Panel, Inc.: Had a telecon with Joe Naroditsky, Power Panel, Inc., Kelley Burke, Buck, Martinez, John Leeds. They need new markets in FL. Introduced Joe to UF (John Lawson), USF (George Phillipides), FAU (Camille Coley).



- Clear Energy Engineering: Interested in energy efficient walk in freezers. Introduced him to Dr. S. Sherif at UF. They communicated to come up with a collaborative project (energy efficient technology for industrial freezers).
- Professional Engineering Corp (PEC): Battery and capacitor testing unit manufacturing co. Requested FESC battery faculty expertise. Sent him the Energy Storage expertise list.
- Martin County Airport/Witham Field: Was introduced to them by John Leeds. Phone communication. Interested in low wind speed wind turbines.
- Steve Willcox, Independent technologist: Developed “Low Temperature Power Generator” technology. Requested funding sources. Introduced him to energy investor contact.
- Lennar: Shared funding opportunities for potential collaboration.
- Schneider Electric: Follow up communication after meeting the contact at the Power Up conference.
- Enterprise Florida: Provided the requested biomass information.
- Melbourne Regional Chamber / Space Coast Tech Council: Discussed their focus and FESC projects to find common points for potential collaboration.
- Gulf Coast Energy Network: FESC signed an MOU with them on March 15, 2016 for collaborative work. Canan attended their Power Up conference and gave a FESC overview presentation. Discussed the 1<sup>st</sup> collaborative proposal opportunity; however proposal response period was too short and it was decided not to pursue.
- OUC: Communication with the board member. Invitation to March 23, 2016 FESC energy meeting at UF. Organization of July 6 face to face board meeting that is being hosted by OUC.
- Duke Energy: Communication with the board member. Invitation to March 23, 2016 FESC energy meeting at UF.
- FPL: Communications with the board member. March 23, 2016 FESC energy meeting agenda preparation.
- Siemens: Communication with the board member and other Siemens contacts. Provided them a tour of the UF wind tunnel facility.
- Treasure Coast Research Park: Discussed USDA grant project progress and USDA\_NIFA funding opportunity.
- Ivy Composites: Communicated with company officials about their new technology (energy efficient deodorization devices and biomass based construction materials).
- Manny Garcia, Blue Whale Skimmers: They developed energy efficient pool circulation system. Requested posting of their information at the FESC industry web page. Their information was posted.
- Petro-Florida Inc.: Requested listing of their company on FESC’s website. Posted their company information at FESC industry site.
- Solar One: Requested listing of their company on FESC’s website. Posted their company information at FESC industry site.
- Koogler and Associates, Inc.: Requested to be listed on the FESC Energy Industry section (under the Energy Efficiency and Engineering Consulting tabs). Posted their information at FESC industry web page.
- Enterprise Florida: Responded to their biomass related question.
- Steve Wilcox, Independent Technologist: Discussed his Low Temperature Power Generator technology. Introduced him to utility contacts.
- Trans World Energy L.L.C.: Follow up on his biomass/fuel cell technology.
- Terviva: Discussed their Pongamia field tests in FL.
- mPower (Will Perego): Discussed their new mPower Solar Generator technology and their crowd funding.
- Capacitech Energy, LLC: UCF spin off company. Shared funding opportunities and introduced him to investors.

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## OUTREACH

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The outreach activities are listed below:

**FESC Website** ([www.FloridaEnergy.ufl.edu](http://www.FloridaEnergy.ufl.edu)): **FESC Website and e-Newsletter:** 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 e-Newsletter:** FESC prepares and distributes electronic newsletters every other month to over 1000 FESC industry/faculty contacts. The e-newsletter provides the current events and funding opportunities. It highlights the accomplishments of FESC faculty and Florida industry. It also covers global energy related news. 3 –newsletters were prepared and distributed during the reporting period. The printable version of the e-newsletters is posted at <http://www.floridaenergy.ufl.edu/publications/fesc-newsletters/>

**FESC Video:** FESC office worked with the UF Journalism Media Services for the video clip development. The video clip can be viewed at <http://www.floridaenergy.ufl.edu/>

**FESC Faculty/Industry Meeting to Educate Students:** Organized a meeting titled as “State of the Union on Florida Energy” that was held on March 23, 2016 at the Reitz Union, UF. The meeting was sponsored by FPL and Duke Energy. The goal was to educate the students about cutting edge energy technologies. The meeting agenda and the presentations are posted at : <http://www.floridaenergy.ufl.edu/fesc-conferences/state-of-the-union-on-florida-energy/>

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## EDUCATION

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The Education program has three focus areas, community college programming at the Associate of Science and certificate level, nuclear energy education, and Undergraduate/Master’s degree in sustainable energy.

The Community College program is in hold due to lack of funding. The Nuclear Energy program was completed.

The university level program has 7 active projects.



### **Progress / Final Reports Submitted During the Reporting Period**

#### ***Buildings and Energy: Design and Operation Vs. Sustainability***

**PIs: Dr. Prabir Barooah, Dr. Duzgun Agdas, and Dr. Ravi S. Srinivasan**

**Project start date:** May 16, 2014

**Project end date:** May 15, 2015

This project is included in this report, because it was not reported in the previous reporting period due to no cost extension request.



## **Summary**

To achieve higher standards in building design and operation, a solid foundation of energy engineering and sustainability principles is essential. At UF engineering, there are no courses offered to students and industry professionals in energy topics particularly related to buildings, specifically for the design and operation in Florida climate conditions. This project fills this void through the development of an energy engineering course.

## **Goals and Objectives**

1. To develop and offer an online undergraduate/graduate energy engineering course for Florida-specific building design and operation.

## **Project Activities, Results and Accomplishments**

Progress made during the reporting period:

**Project Title:** **Buildings and Energy: Design and Operation Vs. Sustainability**

PI: Dr. Prabir Barooah,

Co-PI: Dr. Duzgun Agdas, and Dr. Ravi S. Srinivasan

Institution: University of Florida (Barooah and Srinivasan)

Partners: Queensland University of Technology, Brisbane, Australia (Agdas)

Project Time Period: May 16, 2014 – August 2015

Date: October 2015

### **1. Summary**

Buildings are the largest consumer of energy in the United States, and thus it is crucial to proactively seek ways to improve new and existing buildings' energy efficiency. A solid foundation of energy engineering and sustainability principles is essential to achieve higher standards in building design and operation, so that energy use can be reduced at both national and state level. At the University of Florida (UF) engineering, there are no courses offered to students -- and industry professionals -- in energy topics particularly related to buildings, specifically for the design and operation in Florida climate conditions. Another limitation of existing courses is that they are focused on either design or operation, while design and operation impact energy use in an intertwined manner. This project fills this void through the development of an integrated energy engineering course that emphasizes both design and operation of buildings to achieve energy efficiency.

The course "building and energy: design and operation vs. sustainability" was designed and delivered through University of Florida's EDGE (Electronic Delivery of Gator Engineering) program in Fall 2014 in a combined undergraduate and graduate course. The course was received enthusiastically by the students. The project funding was also leveraged to attract federal research funding, and the collaboration enabled by the project among the PIs have led to joint publications.

### **2. Goals and Objectives**

Improved energy efficiency is a national priority due to the increased focus on reducing the greenhouse gas emissions. It is also a priority for the state of Florida, since the State's larger than US average energy demand and substantial reliance on energy related imports due to lack of local resources<sup>3</sup>. Buildings account for approximately 40% of total energy use in the United States. In view of the high energy intensity, it is crucial for building sector to proactively design and operate high performance buildings.

To achieve higher standards in building design and operation, a solid foundation of energy engineering and sustainability principles is essential. At the University of Florida (UF), currently, there are no courses offered to students and industry professionals in energy topics related to built environments specifically for

the design and operation in Florida climate conditions. This proposed activity aims to fill this void through the development of an energy engineering course that strikes a balance between design and operation. This proposed course builds essential knowledge of building energy and sustainability, and provides necessary background to use building energy simulation software tools.

The proposed activity is the development of a 3 credit hour course with a focus on the relationship between building design and operation to energy and sustainability for Florida climate conditions. The course will be aimed at both graduate and upper-level undergraduate students and will be integrated within different programs in the College of Engineering, i.e. Master of Civil Engineering degree offered via UF EDGE, as well as, the College of Design, Construction and Planning. The aim of the course is to introduce students to energy topics within the context of built environments. The proposed course will cover the basics of building energy concepts from a wider sustainability perspective to advance fundamental understanding of energy and sustainability issues related to building design and operation. Moreover, this course will provide advanced student learning opportunities through Florida climate specific case-studies and professional development activities.

### **3. Project Activities, Results and Accomplishments:**

#### **Activities:**

- The undergraduate / graduate course was mostly designed during summer and Fall 2014, and was taught in Fall 2014. Application for permanent course number was filed in Summer 2014. The permanent numbers have not been assigned yet.
- The course was taught in Fall 2014 under “special topics” course numbers EML 6934 / EML 4930 under the Mechanical and Aerospace Engineering Department. The course was taught as both in-class and online courses; via UF Edge (online course). Video recordings of all lectures are available in UF Edge for access by students taking the online version of this course.

#### **Results and Accomplishments**

- In Fall 2014, 13 students (8 graduate students and 5 undergraduate students) enrolled in its first term. More students and industry professionals are expected to join in the coming years as the course is advertised via UF EDGE and the course is moved to the college of engineering rather than in a specific department.
- The course was enthusiastically received by students. Among the three sections of the course and among the three instructors, the student evaluation on ‘instructor overall’ had a highest value of 4.75.

#### **Benefits to the State of Florida**

1. **Leveraged to obtain federal funding:** The course developed as part of the FESC project was used to enhance the educational and broader impact component of an NSF project proposal by the PI (“Methods of Dynamic Network Identification with Applications to the Control of Smart Buildings, NSF project no. 1463316), which was awarded by the National Science Foundation to the University of Florida, for a total award amount of 300,000 for three years (August 2015-July 2018)
2. **Energy Efficiency Potential Analysis:** For the benefit of the State of Florida, the building energy-modeling project in the course specifically focuses on a retrofit of an existing building in UF campus, i.e., Rinker Hall. The selection of this retrofit project was crucial as students learnt the issues related to Florida-specific climate and the nuances of modeling, calibration, and improving building energy efficiency.

### **4. Concluding Remarks**

The project was successful in many directions. The course was received enthusiastically by the students. The project funding was leveraged to attract federal research funding. Moreover, the collaboration enabled by the project among the PIs has led to joint publications.

Future offerings of the course is expected to attract larger enrollment since by that time it will have its own course number; a special topics course number makes it difficult for prospective students to notice the course in a course catalog. We also feel a condensed version of the course that is completely online (no lecturer involvement) can be offered to distance students as a professional development course.

## **5. Publications**

1. Duzgun Agdas, Ravi S. Srinivasan, Kevin Frost, and Forrest J. Masters, "Energy Use Assessment of Educational Buildings: Toward a Campus-Wide Sustainable Energy Policy." *Sustainable Cities and Society* 17 (September 2015): 15–21. doi:10.1016/j.scs.2015.03.001.
2. Duzgun Agdas and Ravi S. Srinivasan. "Building energy simulation and parallel computing: opportunities and challenges". *Proceedings of the Winter Simulation Conference* 2014 (WSC 2014), Savannah, GA, USA

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

**PI: George Philippidis, Ph.D., University of South Florida (USF)**

**External Collaborators:** Culture Fuels Inc. and Dr. Steve Clarke (retired from Florida Crystals Corporation)

#### **Project Description**

The goal of this project is to establish a graduate education program in renewable energy at USF's Patel College of Global Sustainability (PCGS) by developing two graduate-level courses: (1) "Renewable Transportation Fuels" and (2) "Renewable Power Portfolio". The courses were developed for both in-class and on-line delivery and constitute the concentration in Renewable Energy for the College's existing M.A. in Global Sustainability. They are also included in the new Graduate Certificate in Energy Sustainability offered by the PCGS.

#### **Technical Report**

To date the two courses have been offered for two consecutive years:

(1) Renewable Transportation Fuels (IDS 6207): Fall 2014 and Fall 2015

(2) Renewable Power Portfolio (IDS 6208): Spring 2015 and Spring 2016

The Fuels course is intended to educate students in the technology and business aspects of green fuel production and analyze market dynamics, economics and finance, and sustainability aspects. The Power course is intended to educate students in the technology, business, and sustainability aspects of the various forms of renewable power generation, including solar, wind, biomass, geothermal, and ocean, as well as in energy storage and the smart grid.

Both courses are offered in two sessions: in-class (session 001) and on-line (session 201). They are taught by the PI of this grant (Dr. Philippidis) on Tuesdays at 6:00-8:45 pm at USF's Patel Center and through the Canvas online system.

Guest speakers, primarily from the private sector, are regularly invited to the lectures. Students have expressed strong appreciation for such speakers and for blending classroom teaching with real-world experiences. In addition to a midterm and a final exam, each course involves weekly online discussions and a team research project with the students being split into small teams and selecting a topic of interest (among the course subjects) under the mentorship of the instructor. At the end of the semester each team presents its research findings to the class and produces a written report.

Course evaluations are conducted every semester to identify areas for improvement and implement suggested changes the following year. Additional subject matter experts from USF were engaged by the PI to generate additional instructional material that enhanced the quality of the lectures. Enrollment numbers and student evaluation results will be cited in the Final Report.

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

**PI: Dr. Bhuvaneswari Ramachandran, Assistant Professor, Department of Electrical and Computer Engineering, University of West Florida**

**Co-PI: Dr. Muhammad H Rashid, Professor, Department of Electrical and Computer Engineering University of West Florida**

**Project Time Period: Aug 2014 to July 2016**

**Summary and Progress**

The objective of this project is to introduce a specialization in “Sustainable Energy Systems” for Undergraduate Engineering students at the University of West Florida that could also be used to educate industry professionals towards workforce development. According to the designed curriculum, students are required to take 4 courses from within the Specialization Core (12 credits) and one elective on Environmental Law. The schedule for these courses is provided in the department website

<http://uwf.edu/cas/cas-departments/electrical-and-computer-engineering/specialization-options/sustainable-energy-systems/>

- “Renewable Energy Systems” taught by Dr. Muhammad Rashid, Professor of Electrical and Computer Engineering, was offered during fall 2014 and 34 students had enrolled for this course. Online material was developed and uploaded on to the University’s electronic learning and communicating site ‘eLearning’. Please refer to syllabus attached.
- “Power Electronics” taught by Dr. Muhammad Rashid was offered during spring 2015 and 20 students had enrolled for this course. Online material was uploaded on to eLearning website. Please refer to syllabus attached.
- “Future Energy Systems” was taught during summer 2015 and 58 students had registered to take this online course. Please refer to syllabus attached.
- “Environmental law” is to be offered during spring 2016. Lecture material was developed by Dr. Hal White during this reporting period with assistance from a teaching assistant. Please refer to syllabus attached.
- “Power Electronics” is also being offered during spring 2016.
- “Sustainable Power Systems: Planning, Operation and Markets” will be offered during summer 2016. Lecture preparation is underway and all class recordings will be uploaded on eLearning.

## **Solar Energy Technologies: Fundamentals and Applications in Buildings**

**PI: Cheng-Xian (Charlie) Lin, Ph.D., Associate Professor, Department of Mechanical and Materials Engineering, Florida International University**

### **Project Description**

This project develops a new online course in solar energy technologies, with emphasis on solar applications in buildings, taking account the unique solar resource and infrastructure in the state of Florida. The course will be offered completely online through the Blackboard Learn system. The course targets senior undergraduate students and entry level graduate students who study in FIU as well as other universities in the state of Florida. The course will be offered at least once a year. Students will earn 3 credit hours by taking the course in the Spring, Fall, and/or Summer semesters.

### **Summary of Progress.**

During this reporting period, the following progress has been made toward the offering of a new online course in solar energy at Florida International University:

### **Course listed in university's catalog**

The new online course has been listed in FIU's 2015-2016 catalog for undergraduate students. The course description in the catalog is as following:

*EML 4416 Solar Energy Technology: Fundamentals and Applications (3).* Principles of solar energy conversion, BIPV systems, solar thermal systems - air and water collectors, solar assisted air conditional systems. Prerequisite: EGN 3343.

### **Teaching material development**

The teaching reference materials collected have been evaluated and organized into the course. Although the course is focused on solar thermal technologies, hybrid technologies are also covered. Therefore, some background information about photovoltaic technologies is introduced. In overall, the course is organized in 6 modules including 11 chapters:

#### *Module 1:*

Chapter 1. Introduction

#### *Module 2:*

Chapter 2. Solar Irradiation

Chapter 3. Principles of Solar Energy Conversion: Photovoltaics

Chapter 4. Principles of Solar Energy Conversion: Thermal Collection

#### *Module 3 (A & B):*

Chapter 5. Solar Thermal Systems: Water Collectors;

Chapter 6. Solar Thermal Systems: Air Collectors;

#### *Module 4:*

Chapter 7 Solar Cooling Systems for Air Conditioning

#### *Module 5:*

Chapter 8 PV Solar Energy Systems

Chapter 9. Hybrid Solar Energy Systems



*Module 6:*

Chapter 10 Thermal Analysis of Building-Integrated Solar Components

Chapter 11 Passive Solar Energy

**Online course implementation**

- The online course has been offered in Spring 2016 at FIU through the Blackboard teaching system.
- In addition to powerpoint presentations and list of reference books, the course also included at least two video conference sessions and discussion forums. Students and instructor communicate with each other mostly through online messaging, announcement, and email.
- 17 students registered the online course.
- Students' grade are determined based on the following assignments: quizzes (20%), mid-term and final exams (45%), design project (15%), homework (20%).

**Funds leveraged/new partnerships created**

- The PI is exploring how to leverage the FESC funds for new collaborations or proposals.
- The PI is also planning to write a conference paper based on the online course's implementation and outcome.

**A Certificate Program to Enhance Sustainable Behavior Change Competencies for Educational Outreach Professionals**

**PI: Laura A. Sanagorski Warner, Ed.D. , Assistant Professor, Department of Agricultural Education and Communication, Center for Landscape Conservation and Ecology, University of Florida/IFAS**

**Project Description:** This project supports the development of a certificate program targeting Extension and other educational professionals who conduct outreach education to encourage energy conservation. The aim of this program is to improve the process of program delivery and ultimately increase the adoption of energy-conserving behaviors among participants' clients. This project is important because people need to change their behaviors to overcome environmental challenges. A major focus of this program is program development and delivery incorporating principles of *social marketing*, the application of traditional marketing principles to programs that encourage behavior change that benefits individuals and the communities in which they live. This certificate program has the potential to reach the thousands of individuals who are taught by participants.

**Progress Summary:**

During the current reporting period, the completed certificate program has been promoted and many new participants have been recruited. The certificate program is active (<http://gardeningsolutions.ifas.ufl.edu/clce/socialmarketing/>) and we have found the use of social media to be a very good way to draw in potential participants. During this reporting period, an additional 17 people have earned the certificate, bringing the total to 38 success completions of the *Certificate in Cultivating Community Change*. There are an additional 152 people in the process of earning the certificate. This program has quickly attracted an extremely diverse set of participants representing many organizations. Some of these organizations include: multiple non-profit organizations; U.S. energy organizations; faculty, staff, and students from UF as well as other universities; Extension faculty from UF and a number of other states; NOAA; US Fish and Wildlife; the University of South Florida; and various cities and counties throughout and beyond Florida.

During the current reporting period we were approved for a no cost extension and minor modification to the scope of work. The new expiration date is March 1, 2017. We have reallocated some funds to ensure sustainability of the certificate program. We allocated some funds from the mini-grant program because we determined that the incentive was not needed given the level of participation to date, and we will soon reach our goal of 50 certificates issued. We have added the following to the scope of work: offer some of the less active current and future participants personal contact to provide encouragement to complete the program; additional evaluation; minor program adjustments; and extra promotional activities as-needed.

During this reporting period we conducted initial formative evaluation activities. As described in the project application, we are using the stages of concern, which acknowledges that educators advance through seven stages as they navigate potential adoption of new teaching methods (Hall, 1977), and we applied this to Extension and outreach professionals' adoption of social marketing to energy and natural resources programming (Figure 1).

**Figure 1. Hall's Stages of Change process applied to the adoption of social marketing.**



Formative evaluation has revealed significant gains among program participants. As measured by the stages of concern instrument, the highest percentile score among participants in the pretest was in the informational stage, meaning that these individuals wanted to learn more about social marketing but were not engaged in its use (Table 1).

Table 1.

*Comparison of Social Marketing Certificate Program Participants Stage of Concern Group Profile Pre-Test and Post-Test*

Stages of Concern	Pretest (N = 79)	Posttest (N=24)
Unconcerned	81	61
Informational	90	80
Personal	78	76
Management	47	52
Consequence	27	30
Collaboration	59	68
Refocusing	60	81

*Note.* Numbers in the table represent percentile scores

Upon the posttest, the highest percentile scores were in the Refocusing stage, meaning participants are emerging more concerned about reaping universal benefits from social marketing and how they can adapt this approach to fit with their work. The posttest also reveals a reduction in Unconcerned and Informational scores, which demonstrated increased readiness to adopt social marketing principles because people had not only gained interest but moved beyond gathering information to actually using social marketing principles and tools. Documentation of progress into more advanced stages of concern translates into behavior change among the target audience. Figure 2 provides a comparison of participants' stages of concern pre-test to post-test.

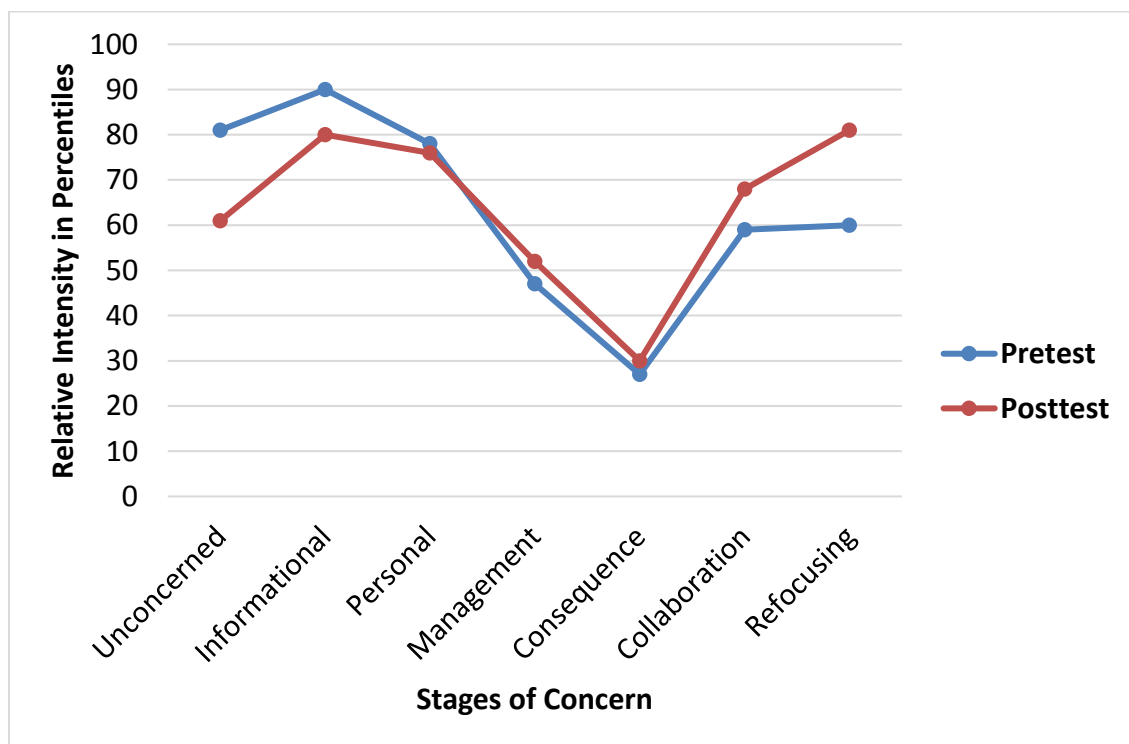


Figure 2. Comparison of social marketing certificate program pre-test and post-test group stages of concern profile

While the quantitative formative evaluation points to success among the early certificate earners, qualitative feedback from certificate program participants can also be useful in demonstrating the program's value. Participant feedback has been incredibly positive and confirms that these individuals have gained the tools needed to apply a science-based approach to changing behaviors in energy and natural resources use. A selection of qualitative feedback is below.

- "I really appreciated the thorough review of learning theory as it pertains to Social Marketing. I had learned the basics of social marketing and have experience with learning theory but it was great to see them both so closely examined. I am further convinced how useful this information is and think we need to share more examples of it's use in Extension. The lessons here are so applicable to different fields and uses!" – A UF/IFAS Extension Agent, 10/11/2015
- "My understanding and recognition of social marketing has grown substantially. I had not been exposed to this information before but after going through these weeks of study I definitely see it's value and many applications where it would be very effective. I think this knowledge will help me to approach community outreach programs in a much more efficient manner that will give my programs a much greater likelihood of having repeatable successful outcomes." – A Natural Resources Specialist for a Florida City, 2/16/2016
- "I had no idea how extensive and detailed the field of social marketing is. My first thoughts were that it was something fairly straight forward, but upon learning about it in greater detail I realize that it goes very in-depth and there are many different factors that play into a successful social marketing campaign. Being a sustainability and the built environment major, this field of work is very useful for facilitating change in our community. Whatever I end up doing, I'm sure that influencing peoples' actions towards a more sustainable path will be inevitable. The skills I learned in this course will undoubtedly come in handy." – A University of Florida participant, 10/16/2015

In the upcoming months, we will continue to promote the program, conduct additional evaluation activities, offer some of the less active current and future participants personal contact to provide encouragement to complete the program; and make final program adjustments to ensure sustainability of this project.

Specific milestones are detailed below:

October 2014:

- Project awarded
- Began meeting with UF instructional designers

November 2014 - December 2014

- Certificate program module design
- Pilot tested paper-based certificate program with Students ( $n = 12$ ) enrolled in UF Practicum in Sustainability and the Built Environment (DCP 4941/DCP 6931) class
- Gave a presentation on this forthcoming program at UF In-service training: *Pharmaceuticals and Personal Care Products (PPCPs)*

January 2015 - February 2015

- Module revision with student feedback into final program components
- Ongoing meetings with instructional designers

March 2015

- Instructional designers delivered the framework for the forthcoming program
- Instructional design ongoing
- Submitted abstract and poster proposal to annual FESC conference

#### April 2015

- Presented a poster on this program at the Department of Agricultural Education and Communication Research and Extension Symposium
- Gave a presentation on this program at UF In-service training: *The Sustainable Floridians Program: From Soup to Nuts*
- Instructional design ongoing

#### May – June 2015

- Video recordings for course lectures completed
- Final certificate program delivered

#### July – August 2015

- Website development
- Soft launch of certificate program
- Mini-grant program application development
- Development of promotional materials

#### September 2015

- Publicity for certificate program, broader advertising activities
- Personally distributed 150 flyers to potential participants
- Direct mailing to 500 outreach organizations
- Course enrollment began
- Launch of minigrant program

#### October 2015 - February 2016

- Publicity for certificate program, broader advertising activities
- Social networking publicity campaign
- Moderate discussion in certificate program's online platform
- Planning for sustainability of course

#### March 2016 - May 2016

- Publicity for certificate program, broader advertising activities
- Social networking publicity campaign
- Moderate discussion in certificate program's online platform
- Planning for sustainability of course
- No cost-extension approved
- Minor adjustments to scope of work

#### **Funds leveraged/new partnerships created**

FESC funds have been leveraged by using students and staff to pilot and review the educational materials.

New collaborations		
Partner name	Title or short description of the collaboration	Funding, if applicable
UF Center for Landscape	Staff donated in-kind time to develop website launch page for both certificate program and mini-grant application	In-kind

Conservation and Ecology		
UF Department of Agricultural Education and Communication	Staff donated in-kind time to develop promotional materials	In-kind
Florida Office of Energy (John Leeds)	Has a listserv that will be used to advertise the program	
Florida Association of Museums	Has a web site that will be used to advertise the program	
League of Environmental Educators in Florida	Has a listserv that will be used to advertise the program	

Grants Awarded					
Title	Agency	Reference Number	PI, Co-investigators and collaborators	Period of Performance	Funding awarded
A Certificate Program to Enhance Sustainable Behavior Change Competencies for Energy-Focused Educational Outreach Professionals	University of Florida	Award # 00071381	Laura Warner, PI Kathryn Stofer, CO-PI	November 2014 - March 2016	\$18,102.26



### **Educational Modules in Support of Sustainable Energy Courses Phase I**

**PI: Juan C. Ordonez, Associate Professor of Mechanical Engineering, FAMU-FSU College of Engineering, Energy and Sustainability Center (Director), Center for Advanced Power Systems, Florida State University**

**Co-PI: Helen Li, Professor of Electrical and Computer Engineering, FAMU-FSU College of Engineering, Center for Advanced Power Systems, Florida State University**

**Project Time Period:** May 2015 – April 15, 2016

Project Description: A series of educational modules on sustainable energy are proposed. The modules will be incorporated initially into existing courses in sustainable energy, thermal fluids and senior design at the FAMU-FSU College of Engineering and later components will be used in non-engineering courses on sustainable energy. The period of performance of this proposal is one year, and during this time modules and supporting material will be developed. The departments and centers involved are committed to give continuity to this effort. The midterm goal is that what is initiated in this project will progress towards a collection of modules that can be assemble into self-standing online courses with hundreds of students as well as hand-picked material to support courses in the energy field. The proposed modules emphasize on real systems and devices to elaborate on relevant aspects of sustainable energy, differing in this way from available online course material. In particular, we propose to develop the modules around FSU's Off-Grid Zero Emissions Building (OGZEB), designed by FSU's Energy and Sustainability Center (ESC) to serve as an energy efficient prototype for developing and testing cutting edge, sustainable energy technologies in both residential and commercial settings. The modules will refer to the OGZEB and use its systems to illustrate different concepts. This will provide continuity to the material, and motivate students through exposure to concrete systems.

The modules proposed are structured into three parts:

- Part I provides an overview of the current energy situation and the status of sustainable technologies that are expected to play a significant role in the future of energy conversion.
- Part II deals with sustainable energy conversion technologies. It covers aspects of photovoltaics, biofuels from microalgae, solar thermal, and fuel cells.
- Part III is on sustainable energy utilization and it covers three modules on two of the major energy demanding sectors: transportation and space heating as well as a module introducing control techniques for energy systems aimed at consumption reduction and improved efficiency.

These modules will be incorporated initially to courses in Mechanical Engineering (EML 4450/5451 Energy Conversion Systems for Sustainability and EML 4452/5453 Sustainable Power Generation), and Electrical Engineering (EEL 4280/ 5285 – Renewable Energy I). Also, due to the nature of the modules and demos, it is expected that they will incorporate well into capstone senior design courses in engineering, and support graduate and undergraduate technical elective classes with energy components. We expect that the incorporation of hardware demos, will enhance the student experience and contribute to motivate them to further pursue developments relevant to the future of Florida's economy in the energy field.

The project will be conducted in two phases. Phase I will have a budget of \$40K to produce two videos. After evaluation to satisfaction \$35K will be made available for Phase II to continue the project. The videos in Module 5 and Module 8 will be produced during Phase I. In the content below, items in *italic* font indicate a demo/module component that will be developed making use of FSU Off-grid Zero Emissions Building subsystems (OGZEB) and supporting infrastructure at the Energy Sustainability Center (ESC). Items in normal font will be part of the material developed but will not necessarily use hardware demonstrations or videos. (\*) Refers to a module that will make use of materials/supplies.

## Executive Summary

A series of educational modules on sustainable energy are developed in this project. These modules are being incorporated into ongoing classes on sustainable energy at the FAMU-FSU College of Engineering and it is expected that they will be later integrated into additional courses in thermal fluids, senior design, as well as non-engineering courses on energy. The midterm goal is that what is initiated in this project will progress towards a collection of modules that can be assembled into self-standing material for online courses as well as hand-picked material to support courses in the energy field.

The modules emphasize on real systems and devices to elaborate on relevant aspects of sustainable energy. In particular, the modules are developed around FSU's Off-Grid Zero Emissions Building (OGZEB) and topics relevant to it and its subsystems. The OGZEB was designed by FSU's Energy and Sustainability Center (ESC) to serve as an energy efficient prototype for developing and testing cutting edge, sustainable energy technologies in both residential and commercial settings. The reference to the OGZEB subsystems will provide continuity to the material, and motivate students through exposure to concrete examples.

The initial courses impacted by the modules are listed in Table I. These courses are currently taught by the PI and co-PI.

Table I. Courses in which modules will be used and target audience.

Course	Typical audience	Typical enrolment
EML 4450/5451 Energy Conversion Systems for Sustainability	Undergraduate and graduate in engineering and science	40
EML 4452 4452/5453, Sustainable Power Generation	Undergraduate and graduate in engineering and science	40
EEL 4280/ 5285 – Renewable Energy I	Undergraduate and graduate in engineering and science	30

In order to track progress, it was decided by FESC to conduct this project in two phases. Phase I (being reported here) consisting on modules covering material on solar photovoltaic and biofuels from microalgae as illustrated in Table II. Phase II will include additional modules covering energy storage, HVAC and residential energy use in the context of the Off-grid Zero Emissions Building.

Table II. Phase I modules topics

Module	Topics
Solar Photovoltaic	Solar resources *OGZEB -solar irradiance measurements (pyrheliometer and pyranometer). Semiconductors Solar cells, Solar tracking *Solar tracking lab demo at the OGZEB Power converters for photovoltaic systems *Demo of PV converters used in the OGZEB. Current and future outlook
Biofuels from Microalgae	Introduction, algae strands, oil content, current status Algae productivity, biofuel potential? Methods of cultivation Methods of extraction Current research efforts (e.g. hydrogen production from microalgae, and compact photobioreactors) *ESC microalgae cultivation

(\*) Refers to a module that makes use of materials/supplies

**Goals and Objectives:**

The goal/objective of this project is to develop educational modules that will be useful to students and instructors in classes covering topics in energy and sustainability.

**Project Activities, Results and Accomplishments:**

The educational modules development has been approached in three fronts: lectures, videos and activities. Below each of these fronts are described:

**Lectures:** Archiving and development of lecture material. Professor A. Krothapalli in 2005 started the development of two technical elective courses in sustainable energy at the Department of Mechanical Engineering of the FAMU-FSU College of Engineering. The courses have been continued by Professor Juan Ordonez until the date. The lecture material used in these courses has been made available to the public. The contents of the lectures are relevant to both Phase I and Phase II of this project.

**Energy Conversion Systems I**

- Sustainable Energy Background
- Solar Strategy
- Solar Radiation
- Solar Thermal
- Thermodynamics of Sustainable Energy
- Quantum Physics of Photovoltaics
- From Sun to Power
- Fuel Cells
- Wind Energy
- Ocean Energy
- Bio Energy
- Geothermal Energy

**Energy Conversion Systems II**

- Intro
- Solar Radiation
- Solar Thermal
- Concentrating Collector
- Face Plate Collector
- Solar Electricity
- Hydrogen Economy
- Hydrogen Production
- Hydrogen Storage
- Integrated Gasification Combined Cycle

**Videos:**

- General video on OGZEB and OGZEB energy systems
- Use of a pyrheliometer and pyranometer for solar measurements
- Solar Radiation Data – State of Florida
- Solar simulator
- Current and future electric grid
- Renewable energy power flow control
- PV array modeling
- MPPT Technology
- Grid-connected PV Generation System
- Energy storage for Renewable Energy System including Lithium-ion battery, Ultracapacitor and Fuel Cells

- Microalgae cultivation in a laboratory setup
- Large scale cultivation of microalgae – tubular photo-bioreactors.

**Laboratories/Homework/ Sample calculations:**

- A design example to size a battery for a residential PV house using a physical battery lifetime model
- Data set and laboratory handout to use in connection with solar irradiance data obtained with pyrheliometer and pyranometer in Tallahassee, FL.
- Instructions and handout on sizing OGZEB PV system using NREL System Advisory Model.

Materials and supplies from this effort were critical in upgrading infrastructure at FSU that allowed preparation of material for the educational modules, below we highlight a few:

- A new set of lights for ESC solar simulator allows for reproduction of solar irradiation conditions in an indoor environment. A video explaining the technical details of the solar simulator, including its operation and characterization is included in the modules. In addition, data from the simulator is being integrated into online homework and other student activities (as part of Phase II).



**Figure 2- ESC solar simulator**

- A video explaining solar irradiance measurements (pyrheliometer and pyranometer) has been produced. Datasets from different days are being made available for students used as part of design exercises.



**Figure 3- Student explaining operation of solar pyrheliometer.**

- OGZEB energy storage system has been upgraded and will be incorporated into the videos.



**Figure 4- OGZEB battery storage system (two 48 V-battery arrays in parallel)**

- d. A weather station integrated into the Energy and Sustainability Center's OGZEB will acquire and make data available online for students to get real, local data into their projects and homework.



- Figure 5- ESC- OGZEB weather station. (Anemometer, Barometer Tendency, Dewpoint, Heat Index, Hygrometer, Rain Gauge, Rain Rate, Solar Radiation Sensor, Soil Moisture and Temperature Probes, Thermometer, UV Radiation Sensor, Wet Bulb Globe Temperature, Wind Chill, Wind Vane, High resolution cloud camera) – time updates every minute made available online.

### **Concluding Remarks**

A web portal to house the modules has been developed. The site will be tested initially at FAMU-FSU with plans of making it publicly available at completion of Phase II of this project.

### **Publications**

- Thermoeconomic Analysis of a Solar Thermal System in an Off-Grid Zero Emissions Building (in preparation)
- Experimental validation of a Volume Element Model for Indoor air temperature and humidity for an Off-Grid- Zero Emissions Building (in preparation).

### **Renewable Energies and Sustainability Education**

**Co-PI's: Dr. Ryan Integlia, Electrical and Computer Engineering, Florida Polytechnic University and Dr. Sesha Srinivasan, Physics/Innovation and Technology, Florida Polytechnic University**

#### **Team Participants:**

Mr. Gary Albarelli, Florida Industrial and Phosphate Research

Dr. Brian Birky, Florida Industrial and Phosphate Research

Dr. Jorge Vargas, Electrical and Computer Engineering

Dr. Jaspreet Dhau, Chemistry and Business

#### **Project Period: October 01, 2015-May 31, 2016**

- 1. Project Summary:** This FESC education proposal is aimed at developing a stand-alone course content accessibility, conducting competitions and workshop that can be offered to undergraduate and graduate students at the Florida Polytechnic University as an elective. The related course materials would be available and accessible by the general public and may provide added awareness and public outreach. This work will be aligned with the renewable energy and sustainability initiatives at the University. This course will create awareness and engagement of various renewable energy systems, technologies promoting sustainable, and economic development concepts supporting entrepreneurship among students and industry (Mosaic and others) that impacts the workforce and the economy of Florida.
- 2. Course Preparation (EEL 3287):** The proposed course “Renewable Energy Systems and Sustainability” (EEL 3287) is officially approved by the University Curriculum Committee and Academic Program Committee of Electrical Engineering and will be offered in Fall 2016 semester (special flyer about this new course is attached at the end of this report). 10 students have enrolled in the course. The syllabi and other logistics of implementing this course with successful learning outcome are currently under preparation by the Co-PIs. Please see the image of the course status
- 3. Progress in the Project Period:** The Co-PIs recruited an undergraduate researcher Mr. Mark Glaser to work on the FESC project activities. Mr. Glaser is currently Chair of the SGA Sustainability Committee. Some of our faculty and students progresses and accomplishments during the project timeline are listed below:
  - a. **EEL 3287 Renewable Energy and Sustainability course** is now in Florida Polytechnic University's Fall 2016 course offering schedule and the course preparations mentioned above are in progress. 10 potential students enrolled in the course currently. The course logistics will be underway which includes, syllabi preparation, book selection, weekly schedule, guest speaker selection, sustainability video competitions etc.
  - b. Students from Dr. Srinivasan and Dr. Integlia's group presented their research works (both oral and poster) at the Florida Academy of Science 80<sup>th</sup> Annual Meeting, March 18-19, 2016, USF St. Petersburg campus. Abstracts of presentations have been published in Florida Scientist Journal, Volume 79, Supplement 1, 2016.
  - c. Dr. Srinivasan presided as a co-Chair of the Engineering section at the FAS 80<sup>th</sup> Annual Meeting, March 18-19, 2016, USF St. Petersburg campus.
  - d. Florida Poly students won the Heys Travel Award, AL Hall Memorial Award, Outstanding oral and poster presentation awards at the Florida Academy of Sciences 80<sup>th</sup> Annual Meeting, March 18-19, 2016, USF St. Petersburg campus.
  - e. Dr. Srinivasan gave his oral presentation on “Synergistic Effects of MWCNT and Nb<sub>2</sub>O<sub>5</sub> on the Hydrogen Storage Characteristics of Li-nMg-B-N-H System” at the MCARE 2016 conference of American Ceramic Society, April 18, 2016, Clearwater, FL.



- f. Dr. Srinivasan was participated at the ONICON & Air Monitor Technology Conference, May 13, 2016, Largo, FL.
- g. FESC funded undergraduate research student successfully executed the first Florida Polytechnic Sustainability Innovation Competition (Fall 2015- Spring 2016). Winning team research project on “Clean Drinking Water and Quality Air via Solar-PV Assisted Photocatalytic Oxidation” was judged by the FL Poly faculty and review team from Florida Industrial Phosphate Research Institute (FIPR).
- h. FESC funded undergraduate research student assisted in fostering interest in EEL 3287, Renewable Energy Systems and Sustainability to meet the roster requirements.
- i. Number of events such as Sustainability Innovation Competition, Earth Day event, Blackout events, have been organized by the SGA Chair of Sustainability Committee and FESC funded undergraduate researcher.
- j. FESC Co-PIs, team participants and students have hosted first Sustainability Gap Google Hangout to widely spread the message about the EEL 3287 course as promotional material which is currently available at the FL Poly Facebook page.
- k. The SGA sustainability Committee Chair and members visited the UCF Aquaponics Garden, in January 23, 2016.
- l. The co-PI Dr. Srinivasan and SGA Committee members with Chair visited the USF Solar Fair on March 26, 2016 in main campus, Tampa, FL.
- m. SGA sustainability Committee under the leadership of FL Poly Faculty Dr. Nicoleta Hickman currently engaged in creating Smart Community Garden at the FL Poly Campus (Summer 2016).
- n. The co-PIs Dr. Integlia and Dr. Srinivasan with other faculty have been awarded an internal seed grant of \$25K to carry out the research on “Biogenic Diatoms for Renewable Energy” (2016-2017).
- o. The co-PIs Dr. Srinivasan and Dr. Dhau with other faculty have been awarded an internal seed grant of \$40K to carry out the research on “Solar PV assisted Photocatalysis” (2016-2017)
- p. The co-PI Dr. Integlia with other faculty have been awarded an internal seed grant of \$50K to carry out research on multiple projects such as Innovative Testing of Autonomous Systems (2016-2017).
- q. The co-PI Dr. Srinivasan and other faculty have submitted their concept paper on the “Demonstration of Synergistic Isogeneous Active Decontamination of Leachate Organic Matter” to Hinkley Center for Solid and Hazardous Waste Management, \$46K (Though encourage for full proposal submission, it was not submitted since FL Poly has not yet attained the accreditation status).
- r. The co-PI Dr. Sesha Srinivasan gave an invited talk on “Hydrogen Energy Storage for On-board Fuel Cells, Concentrated Solar Power and Secondary Batteries” at the Engineering Sciences section of the 80th Annual Meeting of Florida Academy of Science which was held on March 18th at University of South Florida, St. Petersburg campus.
- s. The co-PI Dr. Sesha Srinivasan with USF PI Lead submitted a full proposal on “Advanced Thermal Hydrogen Compressor” with FPU budget of \$200K to US DOE.
- t. The co-PIs Dr. Srinivasan and Dr. Dhau will be submitting a full proposal on ‘Tailored Metal Hydrides for Thermal Storage in CSP’ for the total budget of \$498K to ARPA-E.
- u. The co-PI, Dr. Sesha Srinivasan, Lead Guest Editor and other Guest Editors have recently edited and published a special issue on “Nanomaterials for Energy Environmental Applications” in Journal of Nanomaterials. The editorial section of this special issue and other contributed articles can be accessed from the Hindawi publishers weblink at <http://www.hindawi.com/journals/jnm/si/450272/>
- v. The co-PIs, Drs. Jaspreet Dhau and Sesha Srinivasan submitted a letter of endorsement to the Indo-US 21st Century Knowledge Initiative (formerly the Obama-Singh 21st Century Knowledge Initiative -OSI) through the University Grants Commission, Bahadur Shah Zafar Marg, New Delhi, India. The Knowledge Initiative aims to strengthen collaboration and build partnerships between American and Indian institutions of higher education. If awarded, would provide Florida Polytechnic with The project, "USIndia OSI Partnership on Green Chemistry/Engineering and Technologies Education, Research and Outreach for Sustainable Development" is a collaborative proposal that will address the global challenges in the field of Green chemistry/engineering and technologies and to facilitate the development of an international educational curriculum, exchange of expertise research and outreach activities between the USA and India.

- w. The co-PIs Dr. Integlia and Dr. Srinivasan have submitted a subcontract proposal on “Crowd-Sourced, Cloud-Based Urban Water Quality Survey of Estuaries Surrounding the Indian River Lagoon” EPA Urban Water Small Grant as a subrecipient via Treasure Coast Education, Research and Development Agency (TCERDA)” to EPA for \$15K (2016).
- x. The co-PI Dr. Srinivasan participated at the Physics Congress Retreat in San Francisco, CA, November 5-8, 2015. Dr. Srinivasan on the Planning Committee of the Congress will host the Quadrennial Physics Congress Meeting in November 2016 in Silicon Valley, CA.
- y. The co-PIs Dr. Dhau and Dr. Srinivasan have been inducted as FL Poly Chapter of National Academy of Inventors on March 2016.

**4. Photos of events where the co-PIs and their students participation (Appendix 2)**

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## PROJECT PROGRESS REPORTS

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### Simulation and Measurement of Biomass Suspension Rheology

**PI: Jennifer Sinclair Curtis**, Chemical Engineering, University of Florida

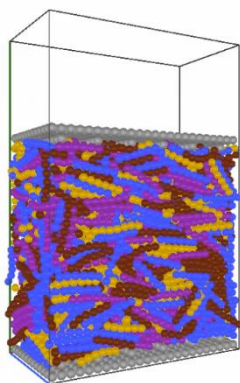
Project Period: 8/2014-12/2016

**Summary:** Biomass is a promising source of renewable energy. Although this form of energy production holds much potential to reduce energy dependence on petroleum-based fuel consumption, *one key challenge in the large-scale commercialization of these systems is the physical handling of biomass suspensions.* These suspensions span a wide spectrum of solids concentrations and particle size during the various biomass processing steps. *Fibrous suspensions are also being used increasingly in petroleum exploration applications.* Fibers have been used since at least the 1960's in petroleum exploration as an additive to well cement to increase its strength. Fibers increasingly are added to drilling muds to alter the rheology in an effort to improve performance of the fluid for the purpose of carrying rock cuttings from the drill bit to the surface. More recently, industry has been using fibrous suspensions to solve critical problems with regard to hydrofracturing.

In this project, a combined program of simulation and experimentation is utilized to investigate the dynamics and rheology of fibrous suspensions of biomass. In order to reliably design and optimally operate biomass processes, the rheological behavior of these complex fluids over a range of solids concentrations and particle size must be understood. On the simulation side, the discrete element method (DEM), capable of calculating stresses and effective viscosity of biomass over a wide span of moisture content (using a liquid bridging model) and particle sizes, is developed. The goal is to study the rheology of well-characterized fibrous suspensions such as fishing wire and then move onto actual biomass (wheat straw). These materials will be fully evaluated via experimentation (angle of repose and shear cell testing) and compared with the simulation results. Successful completion of the proposed work will provide insights into the rheological behavior of fiber-filled suspensions that will aid the design and optimal operation of processes in renewable energy.

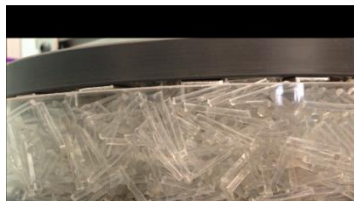
**Goals and Objectives:** The goal/objective of this project is to predict the flow behavior of biomass over a range of liquid content and particle aspect ratios.

**Project Activities, Results and Accomplishments:** Shear flows of dry, flexible fibers were numerically modeled using the Discrete Element Method (DEM) and the effects of fiber properties on the flow behavior and solid-phase stresses were explored. We have verified our DEM model by a comprehensive examination of static and dynamic behavior of particle bending, twisting, and stretching. We have also validated our DEM

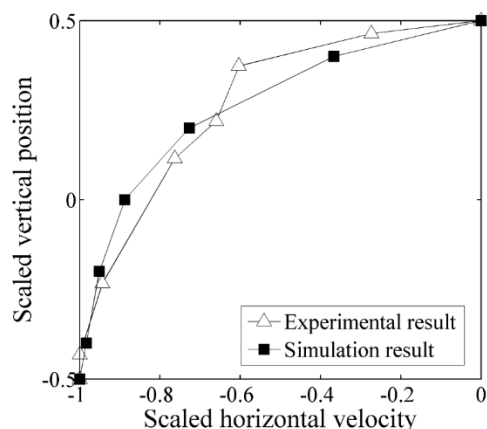


model using Schultz shear flow testing for wet and dry fishing wire and the measured stress is comparable to the simulated stress (shown in the last reporting period). As a reminder, in the shear cell, there is a constant stress that is applied to the top wall and the bottom wall moves horizontally. As a result the top wall can move vertically up and down while the bottom wall does not move vertically. A schematic of the simulation cell is shown to the left.

We have now constructed a clear shear cell (shown below) so that we can perform an even greater level of detailed validation of our DEM model.



By tracking individual fibers in the shear cell – the ones we can visualize near the clear cell wall – we can experimentally measure a velocity profile for the fibrous material. We then compare these velocity measurements to the simulated results.



These results show a favorable comparison of measurement and simulation. In addition, a large portion of the fibrous particles move along with the bottom plate with significant shearing occurring in a narrow region close to the top lid.

**Concluding Remarks:** In the final reporting period, we will validate our DEM model with shear cell experimentation on biomass material (wheat straw). Experiments and simulations with wheat straw are currently ongoing.

#### **Publications:**

Y. Guo, C. Wassgren, B. Hancock, W. Ketterhagen, and J. Curtis, “Computational Study of Granular Shear Flows of Dry Flexible Fibers using the Discrete Element Method”, *Journal of Fluid Mechanics*, **775**, 24-52 (2015)

**Presentations:** Plenary Talk, “Modeling the Transport of Wet, Flexible Fibers”, International Fine Particle Research Institute, Annual Meeting, Cornell University, June 2015  
Aix-Marseille University, “Toward Simulation Based Design of Particle Handling Processes”, Marseille, France, June 2015

**Leveraging the FESC project:** Thanks to this FESC funding which has provided seed funding, we have now received two additional grants for biomass processing work.

BARD (Binational Agricultural Research and Development Fund, “Investigation of Particulate Flow Behavior in a High Solids, Leach-bed Biogasification System”, \$300,000, co-PI, (60% share), September 2015-August 2018

John Deere, “Application of the Discrete Element Method (DEM) for Modeling of Crop Harvesting”, \$64,617, PI, May 2016-May 2017

## **Roadmap to Renewable Fuel Pathway Certification for TCERDA/FESC**

**PI:** Gary Peter

**Co-PI:** John Erickson

**Project Time Period:** 7/1/2015-12/31/2015 and No-Cost Extension till: 06/30/2016

**Background:** The Energy and Security Act of 2007 (EISA) expanded the Renewable Fuels Standards program, 40 CFR part 80 subpart M, and required the Environmental Protection Agency (EPA) to establish procedures for petitioning the agency for new fuels pathways. EISA required EPA to apply a complete life cycle analysis of greenhouse gas (GHG) performance threshold to ensure renewable fuels emit less GHG than the petroleum based fuel it replaces. Approval of a new pathway qualifies the fuel for Renewable Identification Number (RIN) status (<http://www.epa.gov/renewable-fuel-standard-program/fuel-pathways-under-renewable-fuel-standard-program>). For qualified feedstocks the USDA offers growers the opportunity for assistance through the Biomass Crop Assistance Program.

Commercial Aviation Alternative Fuels Initiative (CAAFI), Treasure Coast Education Research and Development Authority (TCERDA), and associated partners are interested in facilitating the submission of a petition for a new renewable fuels pathway using crude sugar isolated from energy beets and/or sweet sorghum and converting it to a hydrogenated farnesene for jet fuel with the AMYRIS process. They have reached out to the Florida Energy Systems Consortium (FESC) to develop a roadmap for pathway approval.

### **Pathway submission process:**

#### **The renewable fuel petition review process:**

In a four step process, EPA analyzes the lifecycle greenhouse gas emissions associated with new fuel pathways to determine if they meet the minimum carbon footprint savings required for approval as a renewable fuel.

<b>Step 1: Pathway Screening</b>	<b>Step 2: Petition Submission</b>	<b>Step 3: Review &amp; Prioritization</b>	<b>Step 4: Lifecycle Analysis &amp; Determination</b>
Petitioner submits the <a href="#">Pathway Screening Tool</a> .	Petitioner reviews details on <a href="#">how to submit a petition</a> .	EPA reviews petition for completeness.	EPA conducts a lifecycle greenhouse analysis.
EPA provides input on preparing the petition.	Based on input from EPA, petitioner prepares and submits a petition.	EPA asks for additional information if needed or rejects if incomplete.	EPA seeks public comment as appropriate.
EPA may find that a petition is not needed.		After accepted as complete, EPA prioritizes for analysis.	If approved, petitioner begins registration.

<http://www.epa.gov/renewable-fuel-standard-program/renewable-fuel-petition-review-process>

### **Step 1: Pathway Screening**

Petitioner uses the EPA's Pathway Screening Tool to provide basic information about the proposed pathway. The EPA reviews this information and provides input on preparing the petition if warranted or may judge that a petition is not warranted. For warranted petitions EPA will indicate their priority status. A petition may not be warranted if the fuel pathway already has been approved, feedstock does not qualify as renewable biomass, the fuel or pathway doesn't align with RFS requirements, or EPA determines it has fundamental issues with the technology that can only be resolved with substantial changes to the RFS regulations. Parties can directly submit a petition without using the Pathway Screening Tool, but these will not receive EPA input prior to submission.

### **Step 2: Petition Submission**

The EPA provides (<http://www.epa.gov/sites/production/files/2015-08/documents/420b15083.pdf>) a handbook (version 1.1) on how to prepare a complete petition. The handbook details the information EPA needs to complete lifecycle greenhouse gas (GHG) assessments for different types of petitions, how to claim confidential business information in the petition, and step-by-step instructions for preparing a complete petition, including ones for new feedstocks. The technical justification summarizes the proposed fuel pathway process modeling flow charts, and similarity and differences with pathways already approved by EPA. The feedstock section describes the feedstock type, and requires additional information for new feedstocks not already evaluated by the EPA.

For new feedstocks the required information is outlined in 40 CFR 80.1416(b)(2), and includes the lifecycle GHG emissions associated with growing, harvesting and transporting, including indirect emissions as required by section 211(o) of Clean Air Act. As quoted from handbook, "It is standard practice for EPA to share the information provided in this section of the petition with relevant experts at the DOE and/or the USDA. This consultation process takes time, and questions raised by such experts may require further clarification by the petitioner. Petitioners are encouraged to consult with relevant experts at DOE such experts in their petition. To expedite the review process as much as possible, petitioners are encouraged to include a signed letter from experts who have reviewed and support the petition as providing a fair representation of the best scientific information available about the new feedstock. Doing so will generally decrease the likelihood of a request for additional information from the EPA."

This section must include a technical definition of feedstock, chemical composition as percentage and their variance or ranges based on peer-reviewed literature, category of renewable biomass, and current and projected quantities of feedstock needed. Estimate of quantity of renewable fuel expected to be produced if pathway is approved forward to 2022. Market potential needs to be developed according to the methods and modeling framework developed for March 2010 RFS rule, including indirect emissions from land use change and other market-mediated impacts. Central to this analysis are feedstock yields per hectare, extraction efficiencies of biomass component (seed oil or sugar) used for fuel, fuel production yields associated with the pathway using the feedstock, and co-products from harvesting, processing or fuel production. Literature documented figures and data from the USDA should be used to the extent possible. Available land and competition for use to grow other crops needs to be evaluated.

EPA provides a spreadsheet to facilitate input of data and sources for this information (Appendix A).

### **Step 3: Petition Review and Prioritization**

EPA reviews petition for completeness and as part of process may request additional information. EPA prioritizes petition for analysis with ranking based on 1) ability to contribute to the cellulosic biofuel mandate, 2) potential to reduce GHG on a per gallon basis, and 3) ability to contribute to near-term increases in renewable fuel use.



#### **Step 4: Lifecycle Analysis and Determination**

Length of LCA and determination stage depends on proposed pathway. Petitions submitted appropriately through the Efficient Producer petition process, EPA conducts expedited reviews. If the pathway is a slight modification of an existing pathway and a straightforward extension of EPA's previous assessments for most LCA components and does not contain significant policy issues then review only involves three steps. If proposed pathway is similar to previously evaluated pathways but requires significant new modeling or analysis using the existing EPA modeling framework and methodology, then review includes a 30 day public comment period upon completion of technical and lifecycle analysis. If proposed pathway requires EPA to develop a new modeling structure or methodology or substantial regulatory changes then the petition needs to be resolved through a rulemaking process.

**Currently approved generally applicable pathways for renewable fuel:** (<http://www.epa.gov/renewable-fuel-standard-program/approved-pathways-renewable-fuel>)

As of December, 2015, twenty generally applicable pathways have been approved by the EPA. Of these twenty, four include jet fuel as a product, and two for ethanol using sugarcane and grain sorghum as feedstocks (see below).

#### **Pathway F**

**Feedstock:** Soy bean oil; Oil from annual cover crops; Algal oil; Biogenic waste oils/fats/greases; Non-food grade corn oil; *Camelina sativa* oil

**Production process requirements:** One of the following: Trans-Esterification, Hydrotreating, Excluding processes that co-process renewable biomass and petroleum

**D-code:** 4 (biomass-based diesel)

#### **Pathway H:**

**Feedstock:** Soy bean oil; Oil from annual covercrops; Algal oil; Biogenic waste oils/fats/greases; Non-food grade corn oil; *Camelina sativa* oil

**Production process requirements:** One of the following: Trans-Esterification, Hydrotreating, Includes only processes that co-process renewable biomass and petroleum

**D-code:** 5 (advanced)

#### **Pathway J:**

**Feedstock:** Sugarcane

**Production process requirement:** Fermentation

**D-code:** 5 (advanced)

#### **Pathway L:**

**Feedstock:** Crop residue, slash, pre-commercial thinnings and tree residue, switchgrass, miscanthus, energy cane, *Arundo donax*, *Pennisetum purpureum*, and separated yard waste; biogenic components of separated MSW; cellulosic components of separated food waste; and cellulosic components of annual cover crops.

**Production process requirements:** Any process that converts cellulosic biomass to fuel.

**D-code:** 7 (cellulosic biofuel or biomass-based diesel)

#### **Pathway P:**

**Feedstock:** The non-cellulosic portions of separated food waste and non-cellulosic components of annual cover crops.

**Production process requirements:** Any

**D-code:** 5 (advanced)

**Pathway S:**

**Feedstock:** Grain sorghum

**Production process requirements:** Dry mill process using biogas from landfills, wastetreatment plants, and/or waste digesters, and/or natural gas for process energy

**D-code:** 6 (renewable)

*No pathways using sweet sorghum or energy beets have been approved to date.*

**Pending petitions for renewable fuel pathways under review:**

Petitions for sixteen pathways are under review. Of these pathways under review a number are relevant to the state of Florida including: three pending petitions for energy beets to ethanol by Green Vision Group and sugar beets to ethanol by Tracy Renewable Energy, most recently, industrial beets to ethanol by Just Beets, based on growing the crop in Florida.

For sorghum, five pending petitions (Abengoa Bioenergy Corp., Agengoa Bioenery of Nebraska, Conestoga Energy, Iogen, and Trestle Energy) will use grain sorghum as a feedstock; two pathways for jet fuel, one using hydrotreating of carbohydrate/Algae (Solazyme) and the other using hydrotreating of jatropha (Emerald Biofuels LLC), and one unidentified company for cellulosic biofuel with pulpwood. No pending petitions include sweet sorghum as a feedstock.

A significant hurdle is obtaining a priority review, as fuels made from the cellulosic portion of the plant material are given priority. Therefore, sugars extracted from the crop are disadvantaged in their priority for review.

**Sweet sorghum and energy beet pathways:**

The pending pathways on energy beets and grain sorghum provide important process background needed to achieve certification for specific crops and process combinations and can be seen as giving EPA experience in evaluating these feedstocks. The work also forms the basis to describe specific steps that can be executed in Florida via FESC to accelerate the EPA Certification and subsequent advanced fuel and chemical processing plant to develop production facilities in the State of Florida. It is recognized that the FESC participants together with the State of Florida can accelerate Florida specific feedstocks and processes in tangible ways that will provide Florida with a competitive advantage in attracting such companies.

Specifically it is recommended that:

- FESC exercise these capabilities with one or more of the feedstocks (beets, sorghum and tubers) under development at the Treasure Coast Education and Research Park (TCERDA) and process types of the TCERDA processor participants (Amyris, Lanzatech and/or REG, Just Beets). These processors are ones that have proven to be successful in locations other than Florida and are now showing commercial interest in FL through their participation in USDA funded Rural Business Development Grant.
- FESC identify and propose to the State Energy Department specific activities that it can execute given the EPA process that will be recognized and utilized in its approvals process aligned with the scale up time frame identified in the TCERDA USDA project providing citrus crop growers added options for execution on their lands most expeditiously.
- For example, use of energy beets and sweet sorghum will require specific market potential analyses (see Appendix B) and yield information obtained from Florida. University of Florida Institute of Food and Agricultural Sciences (IFAS) researchers have published information on sweet sorghum cultivation, production inputs, composition, growing region, and acreage. Little published information on energy beets are available for the regions, however, a number of IFAS researchers have unpublished data on energy beet production for different regions in Florida.

- FESC carefully benchmark the efforts of growers, and agencies (NIFA, USDA ARS) in other states and regions to ensure that their efforts are incremental do not overlap with what has already been initiated through EPA application.
- FESC consult with the Roundtable on Sustainable Biomaterials (RSB), growers, and the processors engaged in FL via the TCERDA program to ensure that whatever steps they have taken to achieve recognition under RSB are directly translatable to their efforts securing their engagement in Florida.

**Appendix A for Roadmap to Renewable Fuel Pathway Certification for TCERDA/FESC Project**

*Data Submission Template for New Fuel Pathway Petitions: See figure on next page (zoom in to see better).*

Data Submission Template for New Fuel Pathway Petitions

**Introduction:** The purpose of this data submission template is to assist parties who wish to submit a petition to the PA pursuant to 0 FR 80.1416 and the F52 Regulations. The petition process for evaluation of the new renewable fuels pathways. "The subpart of 0 FR 80.1416(b)(1) of the petitioning PA must include certain information. This template provides petitioners with additional guidance about the best way to submit data to the PA as part of a petition. Further instructions about how to use the template are provided below.

Directions for Petitions Involving Feedstocks Not Previously Modeled

Using the worksheet labeled #1, Feedstock "fill in the relevant data including description of the data sources. Please provide data using the units listed. If you wish to provide multiple scenarios (e.g., high and low yield scenarios) please duplicate the #1, Feedstock "worksheet and describe the differences between scenarios. Additional rows can be added for spaces needed for other categories. Petitions involving feedstocks should also fill out the #2, Process "worksheet as well.

Directions for Petitions Involving Fuel Production Processes Not Previously Modeled

Using the worksheet labeled #2, Process "fill in the relevant data including description of the data sources. Describe the scenario in context of the data provided. For each scenario provide multiple scenarios (e.g., current and future scenarios) please duplicate the #2, Process "worksheet and describe the differences between scenarios. For each source, please indicate where the data comes from (e.g., utility bills, purchase records, model output, etc) and provide specific citations. For each year, please indicate the vintage of the data (e.g., energy use from 2010). Additional rows can be added for spaces needed for other inputs and outputs. Please provide density and lower heating value of inputs, products, and co-products as appropriate. To the extent possible, provide a question consistent with units. For example, the natural gas energy inputs are reported in the energy inputs to the TUs. For input and output mass and energy data, please indicate the time frame for the quantity data provided (e.g., inputs in terms of lbs/hr, tons/year, etc). All applicable information should be provided in the format that is an unnormalized fuel output basis (e.g., tons feedstock per gallon of fuel produced).

Data Submission Template for Petition Involving Feedstocks Not Previously Modeled

Requested Pathway

Fuel Produced

Feedstock

Process

D-Code Request (see table V.C.7-D-Code Designations)

Scenario/Context for Data

Geographic Location

Year/Time Period

Irrigation

Soil Management

Annual/Renewable

Growing Season

Feedstock Composition	Category	Minimum Value	Average Value	Maximum Value	Units	Data Sources (provide specific citations)	Additional Notes
Moisture (%)					% moisture @ delivery		
Hemicellulose					% dry basis		
Cellulose					% dry basis		
Lignin					% dry basis		
Other (replace with description)					(replace with appropriate unit of measurement)		
Other (replace with description)					(replace with appropriate unit of measurement)		
Other (replace with description)					(replace with appropriate unit of measurement)		
Cultivation							
Yield/Growth					% yield change/year		
Crop Yield (Current)					dry tons/acre		
Crop Yield (Projected 2022)					dry tons/acre		
Harvested Acres (current/most recent)					acres		
Harvested Acres (projected 2022)					acres		
Crop Inputs							
Nitrogen Fertilizer					lbs/acre		
Phosphorus Fertilizer					lbs/acre		
Potassium Fertilizer					lbs/acre		
Herbicide					lbs/acre		
Insecticide					lbs/acre		
Fungicide					lbs/acre		
Lime					lbs/acre		
Diesel (consumed during crop production)					gal/acre		
Gasoline (consumed during crop production)					gal/acre		
Electricity (consumed during crop production)					kWh/acre		
Water (consumed during crop production)					gal/acre		
Other (replace with description)					(replace with appropriate unit of measurement)		
Preprocessing Yield					lbs of processed product/bs of feedstock		
Energy Use (replace with description)					(replace with appropriate unit of measurement)		
Other (replace with description)					(replace with appropriate unit of measurement)		
Growing Regions and Acreage							
(replace with appropriate US region)					harvested acres		
(replace with appropriate US region)					harvested acres		
(replace with appropriate US region)					harvested acres		
(replace with appropriate US region)					harvested acres		
Type(s) of land likely to be used					acres		
(replace with appropriate land type)					acres		
(replace with appropriate land type)					acres		
Type(s) of transportation					miles		
(replace with type of transportation)					miles		
(replace with type of transportation)					miles		
References							

List any additional citations here.

Data Submission Template for Petitions Involving Fuel Production Processes Not Previously Modeled

Requested Pathway

Fuel Produced	
Feedstock	
Process	
D-Code Request (see table C-7-D-Code Designations)	

Scenario: Describe the context for data reported below. For example: Expected average annual operating conditions based on months of data collected in 2010 from a pilot plant in [City, State], "or" "Theoretical maximum yield scenario based on model name modeling," etc.

Mass and Energy Balance Information		Mass		Volume		Lower Heating Value (LHV)		Data Source	
Mass	Energy	Value	Units	Value	Units	Value	Units	Source (Required)	Year
Inputs:									
Feedstocks (specify):								(also list moisture content here)	
Chemicals (specify):									
Others (specify):									
Outputs:									
Fuels Produced (specify):									
Co-Products (specify):									
Waste Materials (specify):									
Others (specify):									
Energy <sup>1</sup>									
Inputs: <sup>2</sup>									
Purchased Electricity									
Purchased Steam and Hot Water									
Coal									
Natural Gas									
Diesel									
CHP									
Others (specify):									
Outputs: <sup>3</sup>									
Excess Electricity Generated									
Others (specify):									

<sup>1</sup> Energy balance information should include all inputs and outputs of energy and process heat inputs and outputs used in the pathway, including such sources produce offsite and/or other energy.  
<sup>2</sup> Energy input information should include all inputs used by type, including purchased electricity, indicate the source, type of fuel required, efficiency and temperature/pressure for any steam or hot water purchased for the fuel.  
<sup>3</sup> The extent to which excess electricity or other heat sources are generated and distributed outside the production facility should be described.

## **Appendix B for Roadmap to Renewable Fuel Pathway Certification for TCERDA/FESC Project**

### ***Project Proposal for Economic Analysis of Sugar Beet Production in St. Lucie County***

#### **Project Funding Proposal**

#### **Economic Analysis of Sugar Beet Production for Biofuels in St. Lucie County, Florida**

By Alan W. Hodges, University of Florida, Food and Resource Economics Department

June 16, 2016

#### **Objectives**

Evaluate costs and returns to sugar beet producers and biofuel production facilities.

Evaluate impacts of new sugar beet production on domestic U.S. sugar/sweetener markets.

Evaluate regional economic impacts of new biofuel industries to the county and state.

#### **Scope of Work**

Compile data on production inputs and costs for sugar beets and other rotational biofuel crops in Florida.

Compile data on capital and operating costs for sugar beet processing and biofuel production facilities.

Compile data on market volumes and prices for advanced biofuels in Florida and the southeast U.S.

Estimate potential change in sugar/sweetener market price and supply in response to increased production, based on commodity supply-price elasticities.

Develop regional economic input-output/Social Accounting Matrix models for St. Lucie County, the east-central Florida area, and the state of Florida using the *IMPLAN* system (Implan Group, LLC)

Analyze economic impacts of changes in final demand for biofuels, and displacement of conventional sugar/sweetener commodities and fossil fuels at the local and state levels.

#### **Budget**

Research Scientist: 3 months FTE @ \$6500	\$19,500
Travel: 5 days @ \$200	\$1,000
Indirect cost for private, or state/local govt sponsor: 28.5% of direct costs	\$5,843
Total	<u>\$26,343</u>
Full indirect cost for federal sponsor: 50% of direct cost	\$10,250
Total with full indirect costs	<u>\$30,750</u>

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**APPENDIX 1 – FUNDING OPPORTUNITIES SENT TO FESC FACULTY**

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**82** funding opportunities were sent to the faculty during the reporting period of **Oct. 1, 2015 to May 1, 2016**. The details are given in the table below.

#	Call #	Title	Agency	Date Posted
1	DE-FOA-0001425	Single-Pane Highly Insulating Efficient Lucid Designs (SHIELD)	US DOE	10/13/2015
2	DE-FOA-0001429	Single-windowpane Highly Insulating Efficient Lucid Designs (SHIELD) - SBIR/STTR	US DOE	10/13/2015
3	DE-FOA-0001414	FY 2016 Continuation of Solicitation for the Office of Science Financial Assistance Program	10/13/2015	10/15/2015
4	DE-FOA-0001431	Atmospheric System Research Program – New Data Products	US DOE	10/19/2015
5	DE-FOA-0001437	Environmental System Science	US DOE	10/21/2015
6	BAA-AFRL-RQKP-2016-0002	Hybrid-Cycle Power and Thermal Management System (PTMS)	Air Force Research Laboratory	10/27/2015
7	NSF 16-504	NSF Industry/University Cooperative Research Centers Program (I/UCRC)	NSF	10/28/2015
8	DE-FOA-0001405	SBIR/STTR FY 2016 Phase II Release 1	US DOE	10/30/2015
9	DE-FOA-0001385	Solution to improve the energy efficiency of U.S. small and medium commercial buildings	US DOE	11/10/2015
10	NA	Hinkley Center for Solid and Hazardous Waste Management: Request for Proposals	Hinkley Center	11/10/2015
11	DE-FOA-0001444	Plant Feedstock Genomics for Bioenergy: A Joint Research	US DOE	11/10/2015
12	NA	DOE - DOE Scholars Program	US DOE	11/10/2015
13	DE-FOA-0001395	Building America Industry Partnerships for High Performance Housing Innovation	US DOE	11/20/2016
14	DE-FOA-0001458	Systems Biology Enabled Research on the Roles of Microbial Communities in Carbon Cycle Processes	US DOE	12/1/2015
15	DE-FOA-0001412	Hydrogen and Fuel Cell Technologies Research, Development, and Demonstrations	US DOE	12/11/2015
16	NA	NASA SBIR/STTR	NASA	12/14/2015
17	DE-FOA-0001482	Earth System Modeling	US DOE	12/21/2015
18	DE-FOA-0001480	Novel Instrumental Techniques for Basic Energy Research: Electrochemistry and Quantum Materials	US DOE	12/21/2015
19	DE-FOA-0001470	Notice of Intent (NOI) to Issue Funding Opportunity for Advancements in Algal Biomass Yield, Phase 2 (NO. DE-FOA-0001471)	US DOE	12/23/2015



#	Call #	Title	Agency	Date Posted
20	DE-FOA-0001434	Notice of Intent To Issue Funding Opportunity Announcement Mega-Bio: Bioproducts To Enable Biofuels (No. DE-FOA-0001433)	US DOE	12/24/2015
21	DE-FOA-0001383	Building Energy Efficiency Frontiers and Innovation Technologies (BENEFIT) - 2016	US DOE	1/7/2016
22	N/A	2016 Southeastern Sun Grant Center Regional Competitive Grants Program	N/A	1/19/2016
23	DE-FOA-0001376	Mineral Recovery Phase II - Geothermal Concepts And Approaches To Validate Extraction	US DOE	1/25/2016
24	DE-FOA-0001463	Radiochemistry Summer School	US DOE	1/25/2016
25	DE-FOA-0001469	Solid Oxide Fuel Cell Innovative Concepts and Core Technology	US DOE	1/25/2016
26	NSF 16-524	Innovations at the Nexus of Food, Energy and Water Systems (INFEWS)	NSF	1/25/2016
27	NSF 16-526	Energy-Efficient Computing: from Devices to Architectures (E2CDA)	NSF	1/25/2016
28	NA	Energy-sponsored student design competition for hydrogen-powered microgrid(s)	US DOE	1/28/2016
29	DE-FOA-0001505	Support of Fossil Energy Research at U.S. Colleges and Universities Including University Coach Research and Research by Historically Black Colleges and Universities and Other Minority Institutions	US DOE	1/29/2016
30	DE-FOA-0001384	Fiscal Year 2016 Vehicle Technologies Program Wide Funding Opportunity Announcement	US DOE	2/1/2016
31	DE-FOA-0001441	Industry Partnerships for Cybersecurity of Energy Delivery Systems (CEDS) Research Department of Energy	US DOE	2/5/2016
32	DE-FOA-0001459	Pre-Project Planning for Advanced Combustion Pilot Plants	US DOE	2/5/2016
33	DE-FOA-0001433	MEGA-BIO: BIOPRODUCTS	US DOE	2/8/2016
34	DE-FOA-0001496	State Energy Evolution And Diffusion Studies II - State Energy Strategies (SEEDSII-SES)	US DOE	2/9/2016
35	NA	Invitation to SISE 2016: Nexus in Chicago - opportunity for student, interns	UIC Energy Initiative	2/10/2016
36	NA	Clean Technology Business Competition Gives Boost to Promising Energy Ventures	US DOE-UCF	2/11/2016

#	Call #	Title	Agency	Date Posted
37	NA	Airport Cooperative Research Program 2016-2017 Graduate Research Award Program	Virginia Space Grant Consortium	2/12/2016
38	DE-FOA-0001531	Regional & Global Climate Modeling & Integrated Assessment Research: An Integration Framework for Multi-Model, U.S. Regional Climate Evaluation that Incorporates Local Human Influences for Research at the Energy-Water-Land Nexus	US DOE	2/15/2016
39	NA	US DOE unsolicited proposals	US DOE	2/15/2016
40	BAA-16-0004	Installation Energy and Water Technology Demonstrations	Department of the Army	2/19/2016
41	DE-FOA-0001530	Climate Model Development and Validation	US DOE	2/19/2016
42	DE-FOA-0001514	Energy Frontier Research Centers	US DOE	2/23/2016
43	N/A	DOE Office of Science Graduate Student Research (SCGSR) Program	US DOE	2/23/2016
44	NSF 16-504	Industry/University Cooperative Research Centers Program (I/UCRC)	NSF	3/22/2016
45	FY 2016-2017 FDSTF	Florida Defense Support Task Force -- FY 2016-2017 Grant Funding Application	FDSTF	4/18/2016
46	DE-FOA-0001564	NEXT-GENERATION ENERGY TECHNOLOGIES FOR CONNECTED AND AUTOMATED ON-ROAD VEHICLES (NEXTCAR)	US DOE	4/19/2016
47	DE-FOA-0001565	Rhizosphere Observations Optimizing Terrestrial Sequestration (ROOTS)	US DOE	4/19/2016
48	NA	Bioenergy Technologies Office Announces Notice of Intent for the Manufacturing of Biofuels, Bioproducts, and Biopower: FOA entitled "Project Definition for Pilot and Demonstration Scale Manufacturing of Biofuels, Bioproducts, and Biopower.	US DOE	4/19/2016
49	OES-OCC-16-005	The Partnership on Women <sup>TM</sup> s Entrepreneurship in Renewables (wPOWER)	Dept of State	4/19/2016
50	DE-FOA-0001538	Methane Emissions Mitigation and Quantification from Natural Gas Infrastructure	US DOE	4/22/2016
51	NA	Innovative and Novel Computational Impact on Theory and Experiment (INCITE) Program	US DOE	4/22/2016
52	DE-FOA-0001562	RENEWABLE ENERGY TO FUELS THROUGH UTILIZATION OF ENERGY-DENSE LIQUIDS (REFUEL)	US DOE	4/26/2016

#	Call #	Title	Agency	Date Posted
53	DE-FOA-0001558	Lighting Alternatives Maximizing Performance & Suitability (LAMPS)	US DOE	4/29/2016
54	DE-FOA-0001563	REFUEL (SBIR/STTR)	US DOE	4/29/2016
55	DE - FOA - 0001528	Computational Materials Sciences	US DOE	3/2/2106
56	DE-FOA-0001456	Innovative Concepts for Modular Oxygen Production in Fossil Energy Gasification Systems	US DOE	3/2/2106
57	DE-FOA-0001498	Collaborative Research in Magnetic Fusion Energy Sciences on International Long-Pulse Superconducting Tokamaks	US DOE	3/2/2106
58	DE-FOA-0001445	Development of Technologies for Sensing, Analyzing, and Utilizing Novel Subsurface Signals in Support of the Subsurface Technology and Engineering (SubTER) Crosscut Initiative	US DOE	3/11/2106
59	DE-FOA-0001532	Commercial Buildings and Energy Code Field Studies	US DOE	3/11/2106
60	DE-FOA-0001556	Research and Development for Next Generation Nuclear Physics Accelerator Facilities	US DOE	3/11/2106
61	NA	Small Business Vouchers Pilot	US DOE	3/11/2106
62	DE-FOA-0001418	Marine and Hydrokinetic Technology Development	US DOE	3/14/2106
63	DE-FOA-0001493	Addressing Risk and Uncertainty in the Future Power System	US DOE	3/24/2106
64	DE-FOA-0001403	CITIES LEADING THROUGH ENERGY ANALYSIS AND PLANNING (CITIES-LEAP)	US DOE	3/29/2106
65	DE-FOA-0001457	Supercritical Carbon Dioxide Pilot Plant Test Facility	US DOE	3/30/2106
66	DE-FOA-0001467	NEXT GENERATION ELECTRIC MACHINES: ENABLING TECHNOLOGIES	US DOE	3/30/2106
67	DE-FOA-0001542	U.S. China Clean Energy Research Center -- Medium and Heavy Duty Trucks	US DOE	3/30/2106
68	N00167-15-BAA-01	U.S. Navy Seeking Energy Conservation Ideas – Updated NSWCCD BAA Announcement	US Navy	4/1/2106
69	NA	Managing Water and Wastewater Utility Data to Reduce Energy Consumption and Cost (by Water Research Foundation )	Water Reseach Foundation	4/1/2106
70	RFA-OAA-16-000012	Energy Regulatory Partnership Program(ERRP)	USAID	4/1/2106

	Call #	Title	Agency	Date Posted
71	DE-FOA-0001513	Industrial Assessment Centers	US DOE	4/7/2106
72	DE - FOA - 0001514	Energy Frontier Research Centers	US DOE	4/8/2106
73	DE-FOA-0001569	Sustainable Ammonia Synthesis	US DOE	4/8/2106
74	DE-FOA-0001564	Next-Generation Energy Technologies for Connected And Automated On-Road Vehicles (NEXTCAR)	US DOE	4/19/2106
75	DE-FOA-0001565	Rhizosphere Observations Optimizing Terrestrial Sequestration (ROOTS)	US DOE	4/19/2106
76	OES-OCC-16-005	The Partnership on Women <sup>TM</sup> s Entrepreneurship in Renewables (wPOWER)	Ocean and International Environmental Scientific	4/19/2106
77	DE-FOA-0001538	Methane Emissions Mitigation and Quantification from Natural Gas Infrastructure	US DOE	4/22/2106
78	NA	Innovative and Novel Computational Impact on Theory and Experiment (INCITE) Program	US DOE	4/23/2106
79	DE-FOA-0001562	Renewable Energy to Fuels Through Utilization Of Energy-Dense Liquids (REFUEL)	US DOE	4/26/2106
80	NOI	NOI to issue FOA - Pilot and Demonstration Scale Manufacturing of Biofuels...	US DOE	4/27/2106
81	DE-FOA-0001563	REFUEL (SBIR/STTR)	US DOE	4/29/2106
82	DE-FOA-0001558	Lighting Alternatives Maximizing Performance & Suitability (LAMPS)	US DOE	4/30/2106

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## APPENDIX 2 – POLYTECH EDUCATION REPORT – PHOTOS

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### Blackout – SGA Sustainability Committee – November 13<sup>th</sup>, 2015

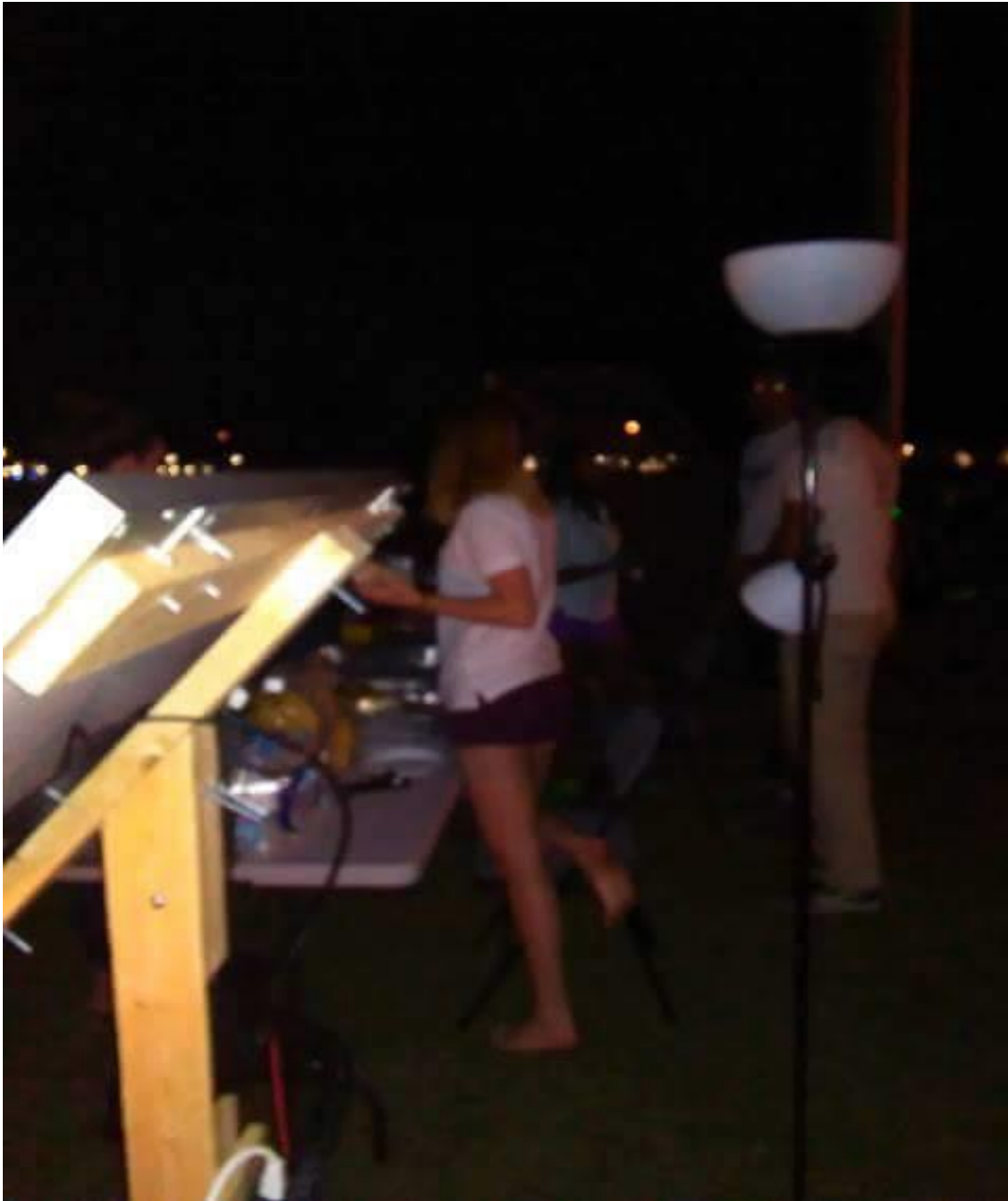




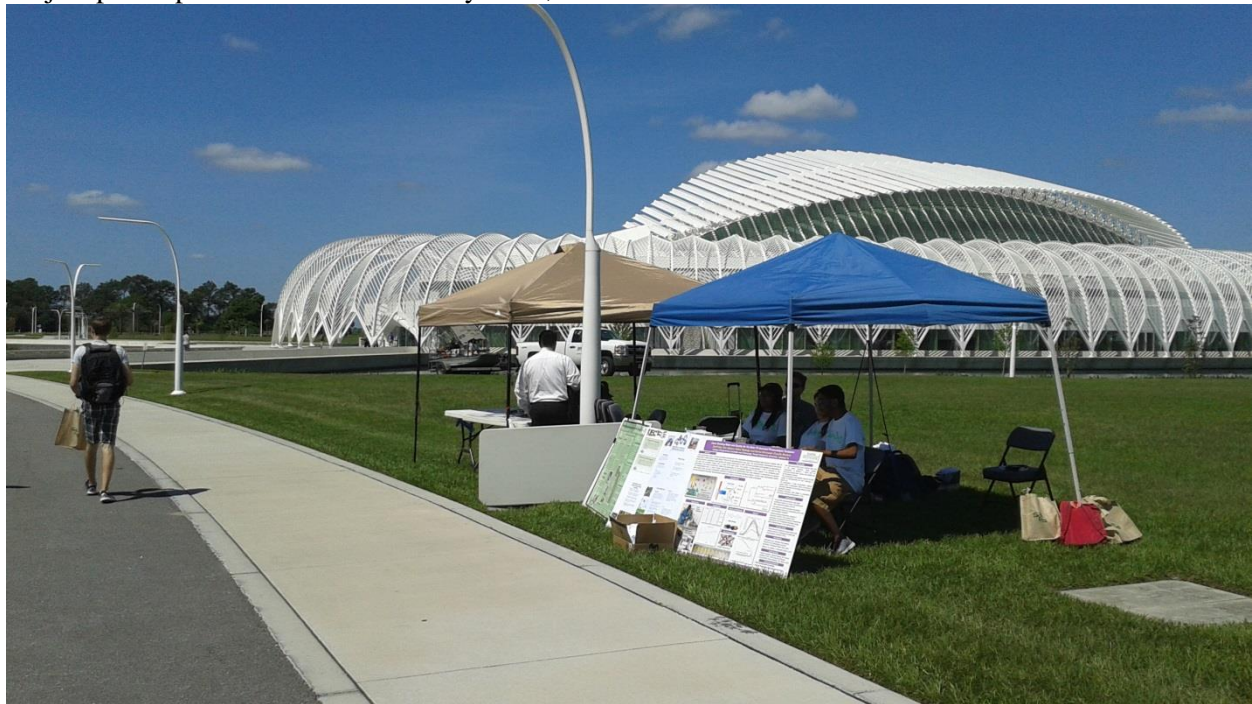
**Blackout – SGA Sustainability Committee and ASTRO – March 18<sup>th</sup>, 2016**



**100 W solar panel and batteries powering lights – food table**



**Florida Polytechnic Sustainability Innovation Competition – Fall 2015 to Spring 2016**  
Project poster presentations – Earth Day 2016, 4/19/16





**Earth Day event – 4/19/16**





**Earth Day event – 4/19/16**





**Visit to UCF Aquaponics Garden construction, Bithlo, FL – SGA Sustainability Committee**  
**January 23<sup>rd</sup>, 2016**



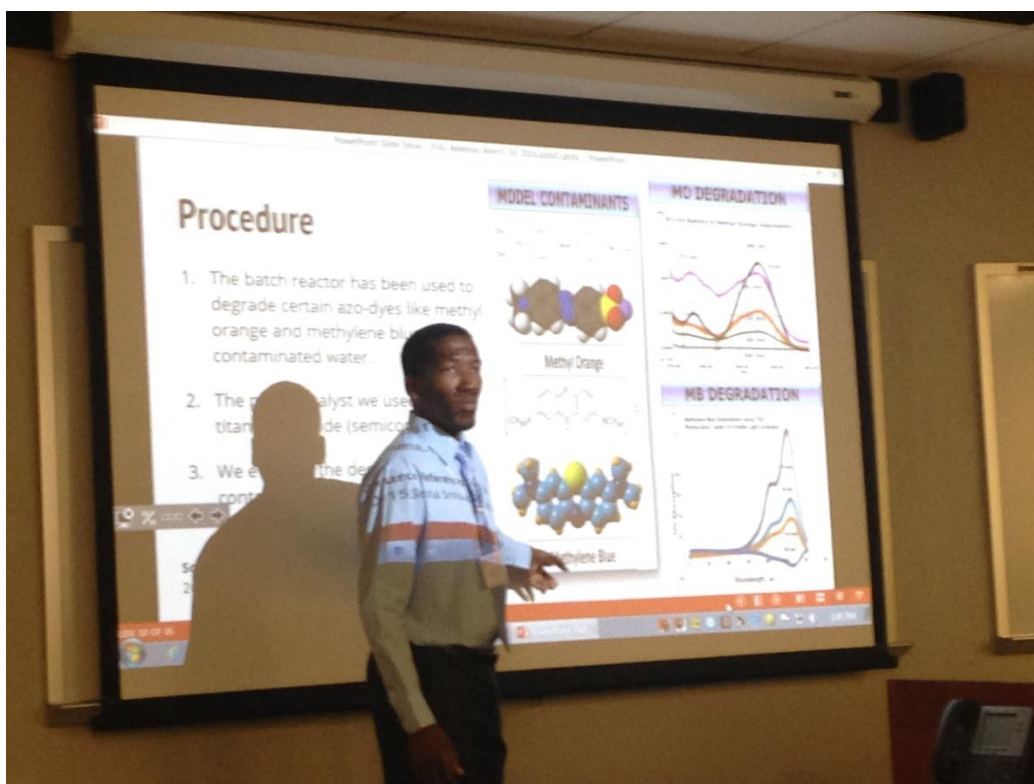
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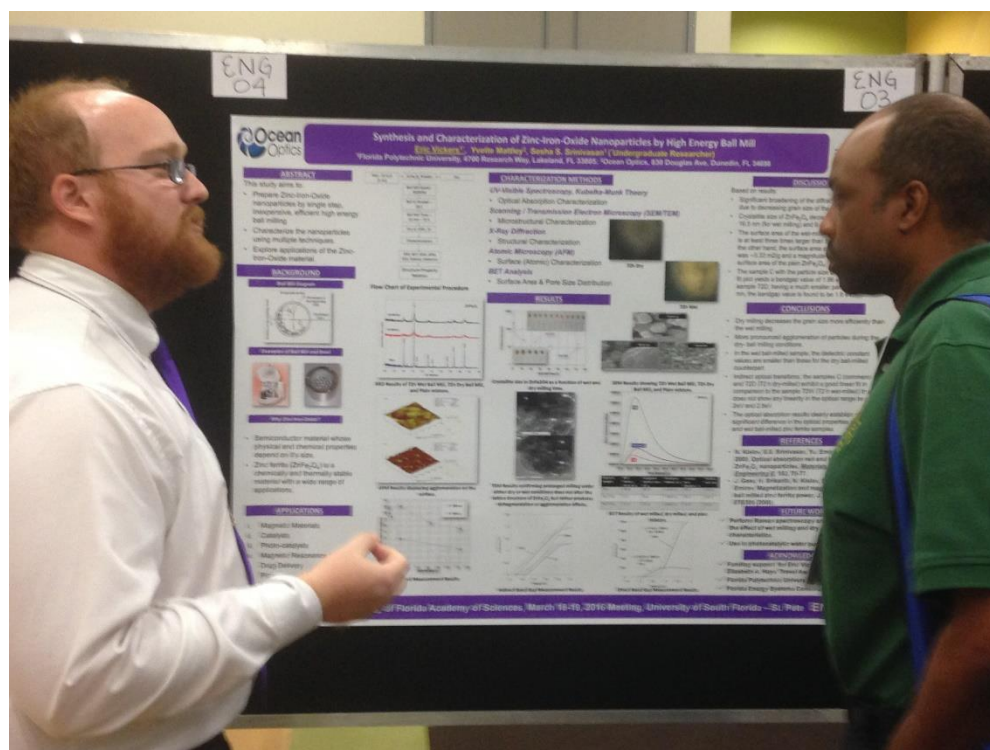
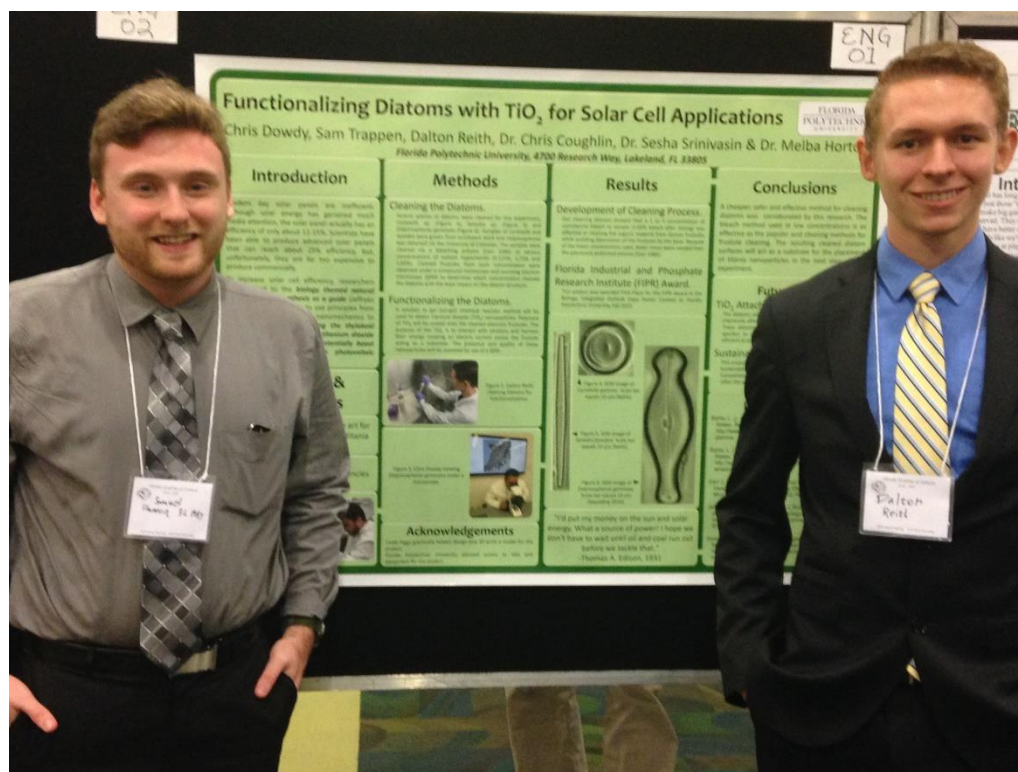
**Smart Community Garden collaboration project – Construction May 2016**







**Florida Academy of Sciences, 20<sup>th</sup> Annual Meeting, March 2016, USF, St. Pete, FL**





**MCARE 2016, American Society Meeting, Clearwater, FL, April 18, 2016**



**ONICON & Air Monitor Technology Conference, May 13, 2016, Largo, FL**



**FL Poly Chapter and Induction Ceremony of National Academy of Inventors, 2016**



**FESC student and SGA Sustainability Committee Chair awarded for hosting competition**





**Sustainability Competition Winner on Clean Drinking Water Project, 2016**



**Sustainability Competition 1st Runner Up Project on Diatom, 2016**



**Sustainability Competition Judges and Faculty Mentors, 2016**



**Dr. Paul Sanberg, Senior VP Research and Innovation and FESC Co-PI at FAS 80<sup>th</sup> Annual Meeting, 2016, USF St. Petersburg**

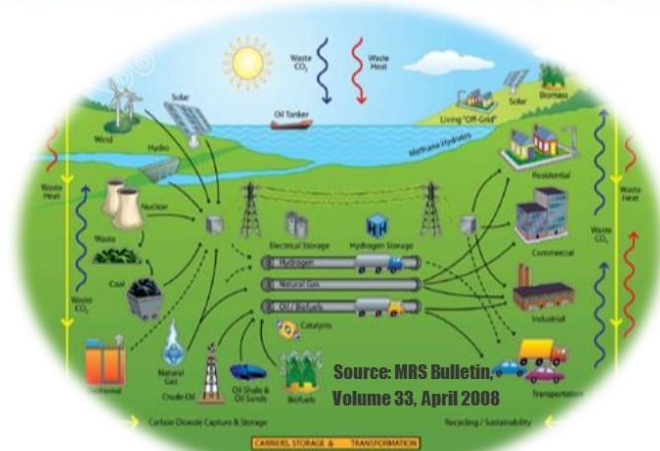


**HURRY UP!! TO REGISTER**

**FALL'16**

**NEW COURSE**

**EEL 3287 - RENEWABLE ENERGY  
AND SUSTAINABILITY - 3 CREDITS**



### **COURSE TOPICS (TENTATIVE):**

**ENERGY HARVESTING • RENEWABILITY • SUSTAINABILITY • ENERGY STORAGE • MATERIALS UTILIZATION • RENEWABLE ENERGY AND SUSTAINABILITY ENTREPRENEURSHIP • SMART GRID AND INFRASTRUCTURE INTEGRATION • HYDROGEN AND FUEL CELLS • ENERGY SYSTEMS AND EFFICIENCY • PLUG-IN HYBRIDS • MARKET SHARE • ECONOMIC DEVELOPMENT • SENSORS • BIOFUEL**

### **OTHER FEATURES:**

**WORKSHOPS • SUSTAINABILITY COMPETITIONS • COLLABORATIVE TEACHING AND LEARNING • PROJECT DEMONSTRATIONS • VIDEO COMPETITIONS • INDUSTRY SUPPORT • FL POLY JOURNAL PUBLICATIONS • INTELLECTUAL PROPERTY • SUPPORT FOR CONFERENCE PARTICIPATIONS • OPPORTUNITY FOR RESEARCH AND DEVELOPMENT • OUTREACH AND INTERNSHIP**

**FLORIDA  
POLYTECHNIC  
UNIVERSITY**

**FESC**  
Florida Energy Systems Consortium

### **COURSE CO-ORDINATORS**

**Dr. RYAN INTEGLIA**

**Dr. SETHA SRINIVASAN**

**Dr. JASPREET DHAU**

**Dr. JORGE VARGAS**

**Mr. Mark Glaser  
(Undergraduate Research Assistant)**

### **GUEST SPEAKERS (TENTATIVE)**

**Dr. BRIAN BIRKY, FIPR**

**Mr. GARY ALBARELLI, FIPR**

**Dr. NICOLETA S-HICKMAN**

**Dr. NAHID MOHAJERI**

**Dr. MELBA HORTON**

**Dr. ROBERT GREEN**

**Dr. SCOTT WALLEN**

**Dr. ROBERT AUSTIN**

### **ELIGIBILITY**

**PERMISSION FROM VP OF ACADEMIC AFFAIRS OR DESIGNEE  
(COURSE CO-ORDINATORS)**

### **CONTACT**

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**SSRINIVASAN@FLPOLY.ORG**

**JDHAU@FLPOLY.ORG**

**JVARGAS@FLPOLY.ORG**

**MGLASER2595@FLPOLY.ORG**

### **VISIT FL POLY CATALOG:**

**[HTTP://CATALOG.FLORIDAPOLYTECHNIC.ORG/  
CONTENT.PHP?CATOID=6&NAVOD=274](http://catalog.floridapolytechnic.org/content.php?catoid=6&navoid=274)**



# Florida Polytechnic Sustainability Innovation Competition

2015/2016 THEME: SOLAR ENERGY

## Timeline

Letter of Intent Due  
September 29, 2015

Project Proposals Due  
October 15, 2015

Approved Teams notified  
November 15, 2015

Project Preview Due  
January 30, 2016

Projects Due  
March 15, 2016

Projects Displayed  
Winner Announced  
April 22, 2016



For correspondence and more info,  
Contact Mark Glaser  
E-mail: [mglaser2595@flpoly.org](mailto:mglaser2595@flpoly.org)



- ♦ Form a team and innovate a solution to a sustainability problem!
- ♦ All teams have a chance to win a \$2500 scholarship prize!
- ♦ Each team of 3-5 students will be given a budget to construct their innovation.
- ♦ Be creative!
- ♦ Projects Displayed and Winners announced Earth Day April 22, 2016.



## **THE FLORIDA POLYTECHNIC SUSTAINABILITY INNOVATION COMPETITION**

Florida Polytechnic University student team competition to innovate solutions to sustainability problems that persist both on the Poly campus and in the world community.

The theme for the first (2015-2016) competition is SOLAR ENERGY.

The competition is open to all students from Florida Polytechnic University and future coordination with additional universities is expected. Participating teams will have the opportunity to submit their project to the EPA's P3: People, Prosperity and the Planet Student Design Competition for Sustainability.

### Timeline:

April 22, 2015:	Competition Announced
Summer 2015:	Form teams, brainstorm ideas, and develop a project proposal.
September 29, 2015:	Letter of Intent to Apply Due
October 15, 2015:	Project Proposals Due
November 15, 2015:	Funded Teams will be notified
January 30, 2016:	Project Preview Due
March 15, 2016:	Projects Due
April 22, 2016:	Projects Displayed   Winner Announced

Only Poly students are eligible to compete.

The prize for the winning team of the competition will be a \$2500 Poly-scholarship prize, split between the team members. The scholarship prize has been provided by FIPR.

### The Project:

The project should focus on SOLAR ENERGY and can concentrate in either technological innovation or educational innovation.

Each approved team will be awarded with a budget to create their project (typical project budgets are expected to range from \$750-1500, depending on materials needed). Up to 10 student teams (between 3 to 5 students) will receive project approval, and funding.

Each team's project will be judged by specific point based criteria (see draft Evaluation Criteria).

The judges of the competition will consist of specially selected students and faculty from all involved institutions. Students and faculty involved in the judging of the competition are not eligible to submit a project proposal. On the final day of the competition, each innovation will be available to the public in order to create interest and promote the concepts of sustainability and innovation in both students and the public.

EEL 3287 Renewable Energy and Sustainability Course in FL Poly Fall 2016 Course Offering Platform:

FLORIDA  
POLYTECHNIC  
UNIVERSITY

Sesha Srinivasan  
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Thursday, May 19, 2016

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Viewing Page #9 (Total Pages: 19)

Course Offering List

Course	Course Name	Credits	Start Date	End Date	Max Enr	Total Enr		
EEL3287ENGR01	Renewable Energy Systems And Sustainability	3	8/22/2016	12/7/2016	30	10		
	Instructor	Room	Days	Date	Start Time	End Time	Max Enr	Total Enr
	Staff	IST-102	W	Weekly	6:00:00 PM	8:30:00 PM	30	10

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