

## FLORIDA STATE UNIVERSITY

### *Establishment of the Center for Marine Bioenergy Research: Systems Approach to BioEnergy Research (SABER)*

**PI:** Joel Kostka **Co-PIs:** William Cooper, Ivonne Audirac, Amy Chan-Hilton, Ellen Granger

**Students:** Claire Smith (Ph.D.), Kristina Welch (M.S.)

**Description:** IESES' Systems Approach to Bio-Energy Research (SABER) is particularly focused on coupling algal cultivation to wastewater nutrient remediation. SABER has partnered with the City of Tallahassee's T. P. Smith Waste Water Treatment Plant in order to study the growth of local fresh water algae in waste water for use as biofuel. The two main objectives of this project are to: 1) perform both laboratory and field experiments to test for species-specific growth potentials, as well as for the effects of different environmental parameters, including light, carbon dioxide, and nutrient availability on microalgal growth rates and lipid production, and 2) determine the extent to which microbes (i.e. bacteria), which are exceptionally abundant in waste water, act as either competitors (for nutrients, carbon) or symbiotically with algae. To do this we are examining the bacterial community present in the waste water and detecting community shifts that occur during algae cultivation. We are also examining the nutrient uptake dynamics between bacteria and algae by monitoring the usage and production of nitrogen, phosphorous, and carbon-containing compounds. Finally, a number of advanced analytical chemistry techniques are being used to characterize wastewater before and after algae cultivation. With a better understanding of the microbial and biogeochemical processes occurring in waste water during algae cultivation, engineering approaches may be proposed in order to further optimize algal growth in waste water.

**Budget:** \$494,135

**University:** FSU

**External Collaborators:** City of Tallahassee

### Progress Summary

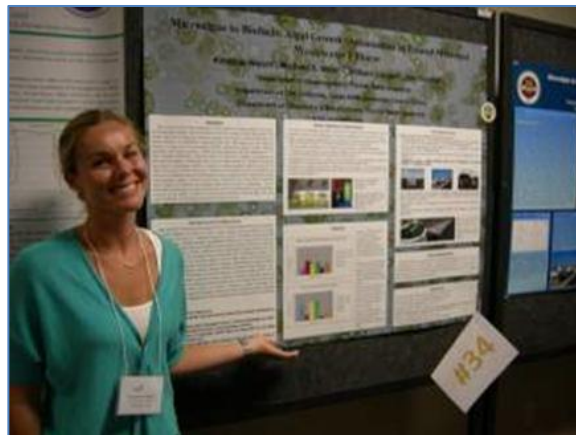
Joel Kostka directs the Systems Approach to Bio-Energy Research (SABER) facility until August, 2011, when he leaves for Georgia Tech. Afterward, Jeff Chanton has agreed to become director and lead the program into the future. Bill Cooper of the Chemistry department and Mike Watts of the FAMU-FSU College of Engineering both serve as SABER Co-PIs and they will continue to support the program by directing students. Timeline and Operation of Facility: Maintenance and day-to-day operations of the facility will be carried out by graduate students, Claire Smith and Kristina Welch. Both of these students will pursue the M.S. degree in the Earth, Ocean and Atmospheric Sciences (EOAS) department. The students plan to finish their degrees in 2012. Both student theses will be directed by Professor Chanton. Kostka will co-direct Claire's thesis research as a courtesy faculty member of EOAS, while Mike Wetz will continue to codirect Kristina's thesis project. Kostka will also serve as a member of Kristina's thesis committee. Bill Cooper has participated in SABER as a coPI since its inception. He has agreed to help run the algal cultivation facility and will serve on the thesis committees of both Claire and Kristina. This arrangement should work quite well.



The SABER group (the students, Kostka, Wetz, Cooper) already has monthly meetings by video chat with Mike Wetz at Texas A&M to discuss the research being conducted by the students. Michael Watts has also participated in SABER PI meetings. The chair of EOAS has agreed to keep the Kostka and Wetz laboratory space intact until the students finish. Kostka has agreed that any and all equipment necessary for both student's research will remain in the Kostka laboratory space until the students finish their theses. All of Kostka's graduate students have helped to run the algal cultivation facility at the Tallahassee Wastewater Treatment Plant and they will continue to do so. Third year Ph.D. students in EOAS, Puja Jasrotia and Andy Canion, will remain at FSU and will continue to be supported on Kostka's federal grants until they complete their dissertations. Puja and Andy will assist Claire and Kristina as needed. Claire and Kristina feel that the algal cultivation system is not difficult to train someone to use. Thus, they have agreed to prepare protocols for operation of the facility, so that future FSU students will be able to step in and continue the research. They will also train students recruited by FSU faculty members to run the facility. Chanton will oversee the operations into the future. Students will be recruited from the EOAS department (Chanton), Chemistry department (Cooper), and the FAMU-FSU College of Engineering (Mike Watts) to continue SABER research.

The SABER team has recently made contact with two organizations that can help to move this project forward in subsequent years. Sustainable Tallahassee is a local non-profit organization that promotes environmental stewardship and economic development through education and collaboration (<http://sustainabletallahassee.org/>). Sharon Liggett, Executive Director of Sustainable Tallahassee, has agreed to promote our algae-to-biofuels program in their Good Green News and Events newsletter and to help recruit volunteers to work at the facility. Volunteers from Sustainable Tallahassee and from the FSU Green Student organization will be trained by graduate students to grow and process algal biomass to supply city bioreactors to produce diesel fuel for the City of Tallahassee fleet.

A second major product of this project will be an environmentally-friendly pilot scale algal cultivation facility that will demonstrate the



SABER Graduate Students at the FESC Summit



production of biodiesel and/or hydrogen from algal biomass grown on wastewater from the Tallahassee Wastewater Treatment plant. The goal is to grow enough biomass to produce diesel fuel and/or hydrogen at the demonstration scale.

Oil that is dewatered and pressed from algal biomass will be converted to fuel in a reactor that the City of Tallahassee operates in conjunction with its automobile fleet. Buddy Driggers is the Parts and Fuel Representative for the City of Tallahassee. At present, he produces 300 gallons of biodiesel per week from cooking oil waste. He estimates his capacity is 300 gallons of biodiesel per day. Mr. Driggers has agreed to test algal biomass in his transesterification reactor. The reactor can be scaled from 5 to 150 gallons depending upon the amount of oil that can be dewatered and squeezed from the algae. Our initial goal will be to produce 5 gallons of pressed oil from algae produced in our open raceway ponds. Biomass will also be thermochemically converted to hydrogen in collaboration with students from Yulu Krothapalli's research group.

Protocols developed by SABER's graduate students will be utilized by new students recruited into the program and by volunteers recruited from the local community by Sustainable Tallahassee.

What is unique about this program is that it offsets the environmental and economic costs of renewable biomass production by utilizing municipal wastewater nutrients. Fertilizers are one of the more costly inputs into the biomass production value chain and traditional biofuel crop production that leads to significant nutrient (fertilizer) runoff to adjacent waterbodies. Our approach will yield significant nutrient remediation capability to the City of Tallahassee along with the production of biofuel. That is, algae will sequester nutrients that would otherwise be discharged to adjacent waterbodies.

**Student(s) Supported:** Claire is currently being supported by IESES. Claire has a fellowship proposal pending at NSF. If that is approved, she will be funded through the summer by NSF. Regardless, after the IESES funding runs out, she will be supported by Kostka by working as an RA on his oil spill research projects. Claire has agreed to this arrangement.

Kristina will continue to be supported by the Dean until she graduates. Kristina has a small budget for materials and supplies, also supported by the Dean.

**Use of Facility and Final Product:** The SABER algal cultivation facility is, and will be, critical for training students to support the bioenergy industry in Florida. One major product of this facility will be that it allows for the training of skilled workers for the bioenergy industry. The bioenergy industry is undergoing burgeoning growth in the state of Florida. Two biomass-to-biofuels companies in particular, Algenol of Bonita Springs and Petroalgae of Melbourne, are growing very rapidly. SABER has made contact with both of these companies and supervisors there have talked about their needs for the hiring of trained personnel. Petroalgae in particular has close ties to FSU as high level officials there are alumni and one has a child attending FSU.

Faculty	Source/ Agency	Project Title	Start Date	End Date	Amount
Kostka, Joel E.	BP/FIO	Penetration, accumulation and degradation of BP DWH oil in Florida sandy beaches	8-1-2010	7-31-2012	\$255,259
Kostka, Joel E.	NSF	Rates and mechanisms controlling the microbial degradation of crude oil from the MC252 spill in Gulf of Mexico beach sands	2010	2011	\$169,591
Kostka, Joel E.	NSF	Request for funds for an oil extraction system and gas chromatograph with mass spectrometer for the extraction and analysis of DWH crude oil in Gulf sands	2010	2012	\$100, 850

