FESC Florida Energy Systems Consortium

Energy Currents

At the USF UNIVERSITY OF SOUTH FLORIDA

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KEY FESC RESEARCH

- Enhancing Energy Efficiency and Conservation
- Zero Energy Homes
- Developing Florida's Biomass Resources
- Liquid Fuels from Biomass
- Harnessing Florida's Solar Resources
- Solar Thermal Power
- Rectifying Antenna Solar Power
- Clean Water using Advanced Solar Energy Detoxification
- Ensuring Nuclear Energy and Carbon Constrained Technologies for Electric Power in Florida
- Exploiting Florida's Ocean and Wind Energy Resources
- Securing our Energy Storage and Delivery Infrastructure
- Power Generation Expansion
- Establishing PV Industry in Florida

Renewable Energy Education

The characteristic quality of FESC is its systematic approach to energy research and education. FESC's aim is to impact the public statewide through various energy-awareness activities (via the FL Cooperative Ext. Svc. and the UF Pgm. for Resource Efficient Communities) in promoting efficient use of energy and alternative energy generation methods — and is also developing a K-14 strategy for developing energy-related curriculum structure and content. The over arching goal is to develop programs that target the general public as well as specific audiences such as builders, land planners, solar panel installers, and architects.

USF-FESC plays an active leading role in FESC's effort to meet these goals. It has fielded several college level courses to develop a trained energy work force through programs at the technician level and for students planning on a Bachelor's degree (see page 2).

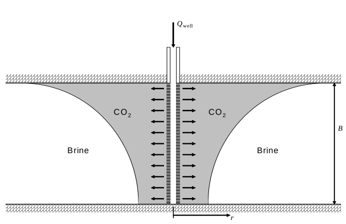
A focal area for USF FESC is the development of a new Master's degree program in sustainable energy. FESC has also partnered with the National Science Found. Advanced Technolog'l Education Ctr. for Florida (FLATE) to implement a systemic change in the way the Florida State College and Community College system designs energy-related A.S. degree programs as well as industry-specific training programs. In addition, FESC disseminates energy curricula in cooperation with FLATE. USF-FESC is working directly with FLATE to develop curriculum for the K-12 sector as well.

"This total commitment by the State of Florida via FESC and its partnership with a NSF-ATE Center of Excellence to meet Florida's 2020 energy related goals represents a unique combination of efforts found nowhere else in the country," explained Richard Gilbert, FESC member and Professor of Chem'l and Biomed'l Engineering at USF's College of Eng. "It is one of the reasons Florida has the nation's model energy program."

USF FESC RESEARCH

Injecting CO_2

Carbon sequestration is under intense scrutiny as an avenue of reducing greenhouse gas emissions.

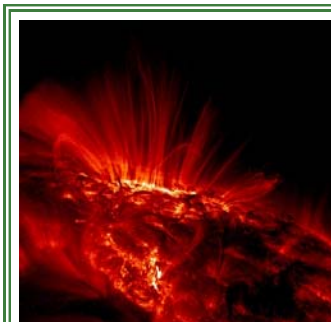


A vertical injection well as a repository for steady CO_2 injection.

Prof. Mark Stewart's team has made significant progress in analyzing the physics and chemistry of supercritical CO_2 injection into deep saline aquifers, the principal geologic carbon sequestration reservoirs identified in Florida. Simulations suggest injection rates up to 8 MT/y may be possible with a single vertical injection well.

Large-scale CO_2 sequestration needs an efficient system for capture. Stewart's team is looking into using a metallic oxide to carbonate the capture process, as well as increasing the system's thermal efficiency and the cycle lifetime.

Analysis of the Florida geology suggests that long-term injection of supercritical CO_2 is feasible.



The beauty of solar energy.

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FESC Universities

The Florida State University System provides the backbone of renewable energy expertise for the Florida Energy Systems Consortium. Member universities include:

- University of Florida
- Florida State University
- Florida Atlantic University
- University of Central Florida
- University of South Florida
- University of West Florida
- University of North Florida
- New College of Florida
- Florida International University
- Florida Gulf Coast University

Renewable energy generated from the sun, biomass, hydrogen, and ocean currents can supply a great portion of Florida's energy needs.

Teaching Renewables

Impacting on the nation's workforce, education is the vehicle which will help drive the transition to a renewable energy future.

Energy, Environment, and Sustainability
ECH 2217
Prof. Yogi Goswami

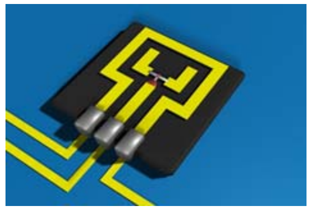
Exploring the use of renewable energy resources like solar energy and biofuels, this class is structured for undergraduate students. ECH 2217 meets the general education requirement for Physical Science. Students will learn to understand and analyze innovative energy systems and technologies that support sustainable energy use, energy security, and environmental harmony for life on Earth. From the perspective of energy engineering, technology and policy, students will examine current energy resources; technologies and applications; and the impact on climate and the environment.

Sustainable Energy
EEL 4935/EEL 6935
Prof. Rudy Schlaf

Understanding the scientific background of conventional and renewable energy production, storage and consumption is the aim of EEL 4935/6935, which is structured for both upper level undergraduates and graduate students. Identifying challenges to implementing worldwide sustainable energy economy, students will learn to quantify the impact of various energy production and storage technologies, as well as paths of energy use and consumption. Assessing the feasibility of the most prominent sustainable energy production methods, students will be encouraged to participate in the current debate about RE.

USF FESC RESEARCH

Harvesting Light



A fabricated scaled prototype of a 94 GHz antenna with diode in the feed point.

Developing a rectenna to convert thermal radiation to electrical energy isn't easy to do — just ask Prof. Shekhar Bhansali and his team. Although highly efficient (~85%) solar rectennas were predicted 30 years ago, serious technological challenges have prevented their becoming a reality. Bhansali's team is working on converting optical solar radiation to thermal radiation (~30 THz regime) using an innovative blackbody source.

MIM junctions were fabricated with different insulators, and they showed interesting electrical characteristics. An improved process was developed to fabricate the tunnel junctions leading to near optimal breakdown voltage.

In the next phase, MIM junctions will be thermally annealed to stabilize the dielectric. Initial studies indicate better dielectric characteristics at 250°C.

The antenna structures have been redesigned to have a MIM junction in its feed point, packaged in a chip carrier. The silicon substrate thermal emitter will be tested using a commercial IR detector and then optimized for rectenna operation.

Phase 2 of the project will see efficiency testing with the fabrication of a simple prototype array of IR rectenna with an IR emitter.

The Bhansali group's intense focus on this project bodes well for the developing science of rectenna energy harvesting.

CERC Clean Energy Symposia Series

High Efficiency PV

New PV manufacturing techniques using highly efficient and reliable materials such as crystalline silicon and GaAs drew a large group of interested researchers, to the November CERC Clean Energy Symposia Series. Greg Nielson, of Sandia National Laboratories in Albuquerque, spoke about how significant PV system cost reductions are needed to achieve grid cost parity.

What is needed is a low-cost, high speed technique to create large numbers of PV panels. One current high speed technique of large amounts of area is roll-to-roll printing. Of the PV technologies that lend themselves to roll-to-roll printing, the use of high efficiency materials allows the lowest balance of system cost for PV systems along with competitive $/W (peak) manufacturing costs of modules.

Greg Nielson is a principal member of the Advanced MEMS Group at Sandia. His work has included microsystem-enabled non-PV approaches to converting sunlight to electricity as well as microsystem based approaches to PV power.

New Faces . . .

Sarada joins the CERC as Dr. Yogi Goswami's Post-doctoral Research Associate. She earned her Ph.D. in Mechanical Engineering in 2009 from the Univ. of Central Florida, where she researched passive liquid-vapor phase separation, and energy storage in phase change materials. Currently, she is working on thermal energy storage for concentrated solar power plant applications and optimization of solid-state H_2 storage materials for IC engine applications.

Sarada Kuravi, PhD

New Roles . . .

Subramanian joins the CERC as Dr. Shekhar Bhansali's Post-doctoral Research Associate. He earned his Ph.D. in Electrical Engineering in 2008 from the USF under the tutelage of CERC Director Prof. Elias Stefanakos. His research focus is in development of next generation energy conversion devices based on thin films. His research interests are in the areas of micro/nanofabrication, materials science and thin film sensors.

Subramanian Krishnan, PhD

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Clean Energy is Green Energy

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The Clean Energy Research Center's mission is scientific research, technical and infrastructure development and information transfer. CERC is involved in fundamental investigations into new environmentally clean energy sources and systems: hydrogen, fuels cells, solar energy and energy conversion and biomass.

CERC Clean Energy Research Center

USF FESC RESEARCH

Critical Milestone Achieved: Storing Hydrogen

QuantumSphere, Inc. and the University of South Florida today announced that they have exceeded the 2010 Department of Energy (DOE) goals for solid state hydrogen storage. Achieving these goals fosters the commercialization of safe, lightweight fuel storage for portable, stationary power, and transportation applications.

In a two year materials discovery program funded by QuantumSphere, Inc., Prof. Elias Stefanakos, director of the CERC at the USF , and Research Associate Dr. Sesha Srinivasan (currently an assistant professor at Tuskegee University), have developed complex metal hydrides doped with QuantumSphere's nano-Nickel particles produced by its patented manufacturing process. These materials have a 6-8 wt% reversible hydrogen capacity below 150°C. This compares to the 6 wt% system efficiency target set by the DOE, as this is believed to be the threshold at which hydrogen can be economically stored as a solid. These results have been confirmed independently by the Southwest Research Institute (SWRI) and the National Institute of Standards and Technology (NIST).

Hydrogen is the most abundant element in the universe and has the highest energy content – three times more than gasoline on a per-pound basis. Unfortunately, it is a gas at room temperature and typically stored in pressurized tanks at 5,000 to 10,000 psi. This presents handling, packaging, safety, and storage challenges and increases the size and weight of power systems. Alternatively, hydrogen stored in the solid state requires lower pressure (100 to 1,000 psi), is safer to handle, and has a simplified, lightweight tank design. However, prior to the QuantumSphere and University of South Florida breakthrough, there had been limited success in discovering solid-state materials capable of effectively storing hydrogen reversibly at practical operating temperatures. This has limited the deployment of hydrogen as a fuel carrier for portable electricity generation.

Prof. Elias Stefanakos

"The high-performance materials designed by QuantumSphere and CERC enables high energy density, solid-state, reversible hydrogen storage systems and will foster the commercialization of hydrogen fuel cells," said Prof. Stefanakos. "Fulfilling the need for lightweight storage is especially important in early market applications such as uninterruptable power supplies and unmanned systems."

"We are impressed with the high caliber of research performed at the University of South Florida," said Dr. Kimberly McGrath, director of fuel cell research at QuantumSphere. "We are focused on demonstrating the value of these new materials at the system level for power applications in the 1-10kW range." Dr. McGrath added, "Furthermore, the fundamental nanomaterials knowledge we have gained has directly translated into the development of higher capacity materials for nickel-metal hydride batteries."