FESC Florida Energy Systems Consortium

Energy Currents

At the USF UNIVERSITY OF SOUTH FLORIDA

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Addressing Florida's Energy Needs

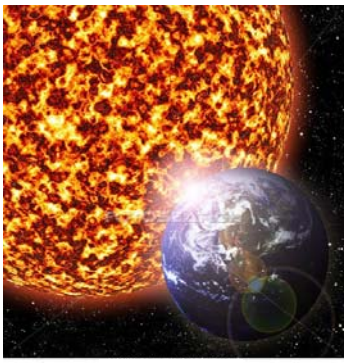
With the cost of gas and electricity rising seemingly by the day, Florida's universities will work together on research aimed at boosting a largely untapped resource: renewable energy.

The Florida Energy Systems Consortium (FESC) was created in the energy bill signed into law by Gov. Charlie Crist in June 2008 in Miami. The FESC will promote collaboration among experts in the State University System (SUS) for the purposes of sharing energy-related expertise and assisting in the development and implementation of a comprehensive, long-term, environmentally compatible, sustainable and efficient energy strategic plan for the state.

The FESC will focus on the research and development of innovative energy systems leading to alternative energy strategies, improved energy efficiencies, and expanded economic development for Florida.

FESC's goal is to become a world leader in energy research, education and technology, and energy systems analysis. Four key strategies will be used to make progress toward this goal:

- Coordinate and initiate greater collaborative interdisciplinary energy research;
- Support the creation of a Florida energy technology industry;
- Provide a State resource for objective energy analysis;
- Develop education and outreach programs to prepare a qualified energy workforce and informed public.



USF Centers and Colleges in the FESC

Centers and colleges involved within the FESC at the University of South Florida include:

- Clean Energy Research Center
- Center for Urban Transportation Research
- Dr. Kiran C. Patel Center for Global Solutions
- College of the Arts (School of Architecture and Community Design)
- College of Arts and Sciences
- College of Engineering
- Power Center for Utility Explorations
- Nanomaterials and Nanomanufacturing Research Center

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Universities Addressing Florida's Energy Needs

FESC Universities

Florida Energy Systems Consortium

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

"Rely on renewable energy income, not depletable energy capital." (Amory Lovins, CEO, Rocky Mountain Institute)

Key Research Areas

- Enhancing Energy Efficiency and Conservation
- Developing Florida's Biomass Resources
- Harnessing Florida's Solar Resources
- 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

USF FESC RESEARCH

Beyond Photovoltaics

Shekhar Bhansali, PI
Electrical Engineering

The core technology is known as the rectenna, (made of an antenna and a rectifying diode). The wideband antenna collects and concentrate a range of photon energies onto the high frequency diode. By placing the rectifying diode at the tip of the antenna, efficiencies are close to 80%. An adequately designed system can potentially absorb the entire solar spectrum. This system can also harvest ambient radiation enabling electricity generation 24 hours per day.

Recent advances in nanotechnology will allow rectenna technology to be manufactured at much lower cost than traditional PV. This technology should reduce the present solar cost of production from $/watt to ¢/yard of flexible solar panels.

USF FESC RESEARCH

Establishing PV Industry in Florida

Among many problems confronting Florida and the US, two stand out: over-reliance on fossil fuels and pollution. By enabling the rapid deployment of an alternative energy source – solar – we will decouple our dependence on foreign oil; and by transitioning to solar photovoltaics (PV) we will mitigate pollution by using this clean form of renewable energy. Significant deployment within the state and country will favorably impact the environment and enhance our quality of life. These goals will help jump start a new manufacturing industry within the state with significant skilled job creation. This will help address our current economic crisis and lay the foundation for the state and country to recapture our strong manufacturing base.

Photovoltaic solar energy has entered into a period of record growth. This is the result of the technology base that has been developed and the visionary efforts of private industry. While the U.S. was in a lead position early on, it has lost the lead to Europe and Asia whose governments are aggressively pursuing solar and providing the economic climate for its growth and success. More than 27,000 new jobs have been generated in Germany alone as a result of its adoption and promotion of photovoltaic solar energy.

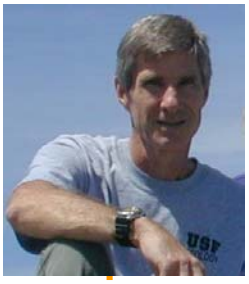
Don Morel, PI
Electrical Engineering

USF FESC RESEARCH

Carbon Sequestration

Since 2007, Florida has been ordered by Governor Crist to reduce greenhouse gas emissions within the state. Accordingly Florida power utilities are required to reduce emissions of CO_2 to year-2000 levels by 2017, to 1990 levels by 2025, and to 80% of 1990 levels by 2050. Development of economically realistic and technically viable technologies to reduce, sequester, or avoid CO_2 emissions is critical to the ability of Florida's utilities to meet the electrical power requirements of Florida's growing economy.

A promising technology to meet this challenge is carbon capture and sequestration (CCS). In the CCS technology, CO_2 is captured from stationary sources (e.g., fossil fuel-fired power plants), compressed and stored (sequestered) in a geologic repository such as a deep saline aquifer. The ability to effectively sequester carbon dioxide will allow Florida to continue to use coal to produce electricity while still meeting the requirements of the governor's executive order.



Mark Stewart, PI
Geology

USF FESC RESEARCH

Zero Energy Homes

Stan Russell, PI
Architecture

Featuring the most cost-effective combination of renewable solar energy with high levels of building energy efficiency, the creation of an affordable residential scale zero energy home will be an example for the public. The building will incorporate a carefully chosen package of the latest energy-efficiency technologies and renewable energy systems to achieve the most successful and reliable results.

Using PV electricity and solar domestic hot water heating systems the house will produce more energy than needed during the day and rely on the grid at night. Plug-in hybrid automobile technology (PHEV) offers a promising means of providing distributed energy storage for such homes but has not been sufficiently tested. Using a systems approach to couple zero energy home technology with PHEVs opportunities will be explored to develop marketable products that meet Florida's energy and environmental goals.

Energy policy interacts complexly with daunting challenges:

- *Economics*
- *Oil Dependence*
- *Climate Change*

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Energy Delivery Infrastructure

Simulating the effects of a renewable energy generation system in a microgrid context to the distribution grid system is the goal of PI Alex Domijan's Power Center for Utility Explorations (PCUE). The project will simulate the combination of renewable distributed generation and a battery system to assess effects during critical conditions such as power system peak.

Microgrids give a number of promising advantages to the electric power industry. A decrease of greenhouse gas emissions and the mitigation of climate change are some of the environmental benefits of microgrids.

Alex Domijan, PI
Electrical Engineering

Microgrids allow a reduction in electricity distribution systems losses by reducing the physical and electrical distance between generation and loads. Another advantage is the creation of new jobs required to produce, install and maintain these generation devices.

USF FESC RESEARCH

Power Generation Expansion

Tapas Das, PI
Industrial Engineering

Florida has a goal of progressive reduction in greenhouse gas emissions by 2025. Recent demand projections show Florida is expected to see one of the highest increases in generation capacity requirements in the next 20 years. Given the demand projections and Florida's position as the second fastest growing state in the USA with respect to annual increase of greenhouse gas emissions, Florida is clearly at the threshold of a major "restructuring" of our portfolio of investments in generation technologies.

Das' project aims to develop a comprehensive generation technology-based portfolio optimization model and its solution algorithm, and develop educational resources to enhance training of a scientific workforce for Florida. This will directly address three major challenges:

- Fulfillment of growing power demand;
- Meeting emissions targets;
- Supply a technology workforce.

Sustainable Energy

Renewable energy generated from the sun, biomass and ocean currents can supply a greater portion of Florida's energy needs — while improving our environment, increasing fuel diversity and spurring economic development. Nature offers a variety of freely available options for producing energy with Florida's robust agricultural community. It is mainly a question of how to convert sun light, biomass or water into electricity, fuel, heat or power as efficiently, sustainably and cost-effectively as possible.

USF FESC RESEARCH

Clean Drinking Water

The availability of fresh water is a big problem facing Florida. In many locations, Florida's water is contaminated from leaky underground tanks and agricultural pesticides. Although salt water desalination is possible, conventional systems are too energy intensive. Solar energy can supply the power, and innovative vacuum and humidification/dehumidification desalination systems can provide adequate fresh water for the state's needs. Stefanakos' team will develop water desalination for small community needs and also in bulk. Another goal is to develop photocatalytic disinfection to remove contaminants and integrate these technologies with solar PV for complete water supply systems. Projects include:

- Natural Vacuum Solar Flash Desalination: Creating vacuum conditions above liquids increase their evaporation rates. This can be integrated into a practical continuous desalination process by flashing sea water in vacuum chambers to produce water vapor that will be condensed, producing fresh water.
- Solar PV Assisted Photocatalysis for Air/Water Disinfection: Improving titanium dioxide photocatalysts for purification and disinfection of water and air contaminated with organic, heavy metal and microbiological species, using solar energy.

Lee Stefanakos, PI
Electrical Engineering

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Solar Thermal Power

Florida utilities are mandated to achieve 20% renewable energy contribution to their generation mix by 2020. While technologically feasible with solar energy, the capital costs are high – presently, capital costs range from $6,000-$7,000/kW for PV and $3,500-$4,000/kW for concentrating solar thermal power. To achieve grid parity, these costs need to be brought down to about $2,000/kW.

The costs will be brought down in this concentrating solar thermal power (CSP) project by introducing lower cost solar collectors and a new combined power and cooling thermodynamic cycle for converting solar heat to electrical power.

Goswami's team will design and construct a 100 kW pilot CSP solar thermal plant. This plant will supply power to the campus and also serve as a research site for introducing innovations being developed in FESC. Thermal energy storage will also be used to extend the time period of the solar power beyond the daylight hours.

Yogi Goswami, PI
Chemical Engineering

Congressional Tours

In April, congressional aide to US Rep. Cathy Castor, Nathan Taylor, toured the CERC labs to learn about our research, in order to brief Castor on renewable energy technologies under development here.

Florida State House Representative David Rivera toured the CERC labs in February, on a fact finding mission for the House Full Appropriations Council on Education and Economic Development. His input to the State Legislature will be important.

CERC graduate student Kofi Dalrymple demonstrates the photocatalytic disinfection process, to Florida Rep. David Rivera.

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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

Liquid Fuels from Biomass

Florida has abundant renewable energy in the form of biomass including municipal, industrial and agricultural waste and disaster debris. The technology for producing clean-burning fuels from biomass and waste products is on the cusp of being commercialized.

Joseph's project aims to develop economical thermo-chemical conversion of non-food grade biomass (citrus peels, switch grass, agricultural and municipal green waste, and bagasse from sugar mills) to clean-burning liquid fuels.

In the thermochemical route, biomass is gasified using steam to produce syngas. The syngas is cleaned and converted to liquid hydrocarbon fuels using the Fischer-Tropsch synthesis method which is used around the world to produce liquid fuels from natural gas and from coal.

Five of the major advantages of this process over a biochemical route to production of ethanol are:

1. Non-food grade feed stocks don't compete with agricultural food production.
2. The fuel's energy content is similar to petroleum unlike ethanol fuels which have a lower energy content.
3. The conversion uses fast chemical reactions unlike the slow biological reactions for fermenting alcohol.
4. It does not require large amounts of water and associated energy costs of separating the water from the fuel as in bioethanol processes.
5. A variety of biomass sources can be used unlike the biochemical route which cannot work with high lignin biomass.

Babu Joseph, PI
Chemical Engineering