The State of FSEC

James Fenton
Advisory Board Meeting
November 18, 2019
FSEC IN THE NEWS
Florida Solar Energy Center
Published by Sherri Hornig Shields · November 4 at 2:43 PM

FSEC in the news...

UCF EDU
UCF Leads National Team to Study Floating Solar | University of Central Florida News

349 People Reached
52 Engagements

Boost Post

2 Comments 2 Shares

ORLANDOSENTINEL.COM
Orlando utility to launch $9 million hydrogen system and more than double solar energy

185 People Reached
28 Engagements

Boost Post

5

2 Shares
The team at UCF’s Florida Solar Energy Center has done some research into what is making our electricity meters spin and ways to reduce energy costs in Florida homes.

https://energyresearch.ucf.edu/consumer/buildings/priorities/

40% Heat/Cool  20% WH  20% Appl  20%

How to Reduce Energy Costs in Existing Homes – Priorities – FSEC Energy Research Center
Tuesday webinar: New test for microcracks will ‘push the industry to exceed benchmarks’

A new test design from the University of Central Florida has challenged modules with different cell technologies. The results show advantages for the heterojunction modules tested. Here we discuss the new method with its designer.

SEPTEMBER 2, 2019  MICHAEL FUHS

pv magazine: You developed a more realistic test sequence for mechanical load testing which simulates snow, then vibrations caused by wind, then daily temperature variation, then vibrations again. How do you implement this and what is difference to the standard tests included in the IEC [International Electrotechnical Commission] certification?

Eric Schneller, research scientist at the Florida Solar Energy Center institute of the University of Central Florida: The standard IEC sequence that aims to capture cell cracking involves cyclic mechanical loading followed by 50 thermal cycles and 10 humidity freeze cycles. We have implemented a modified sequence that uses this existing test sequence as the core, adding one step before and one step after. To start we use a large, front-side, static mechanical load to create cell cracks. The existing sequence then works to open up these cracks. Finally, an additional cyclic mechanical load is used to stress the cells after thermal exposure.

Microcracks develop under cold temperatures and pressure.

*Image: University of Central Florida*
The U.S. Environmental Protection Agency recognizes

Florida Solar Energy Center

for its outstanding commitment to energy-efficient new homes and for contributing

2,399

ENERGY STAR certified homes in 2018
COLLABORATIVE PARTNERSHIPS
FSEC Collaborative Partnerships

PV, EVs, Energy Efficient Buildings, Load Management, Batteries, Alternative Fuels, Hydrogen, Fuel Cells, Smart Grid Electronics, V2X, Training & Education
Current DOE-Funded Collaborative Partnerships

- Fabrication of Passivating Contact Solar Cells, *K. Davis*
- PV System Research Impacting LCOE, *J. Walters*
- Reliability and Power Degradation, Sub from CWRU, *K. Davis*
- Improving Solar Panel Durability, Sub from Brightspot Automation, *H. Seigneur*
- Characterization of Contact Degradation in c-Si PV Modules, *K. Davis*
- Low Cost Printing Techniques, *K. Davis*
- Solar Energy Innovator Program, *Paul Brooker at OUC*
- Orlando: Renewable and Resilient, Sub from City of Orlando, *J. Fenton*
- Quantifying and Valuing Fundamental Characteristics and Benefits of Floating Photovoltaic Systems, *J. Sherwin*
Current DOE-Funded Collaborative Partnerships

- Integrated HVAC control for Mini-Spit Heat Pumps, E. Martin, K. Fenaughty, D. Parker
- Investigation of the Prevalence and Energy Impacts of Residential Comfort System Faults – Hot Humid and Hot Dry Climates, E. Martin, D. Parker, C. Withers
- Indoor Air Quality Field Study in New US Homes, E. Martin, C. Withers, D. Chasar, J. Sonne
Current DOE-Funded Collaborative Partnerships

Continue to develop and support users of the Energy Department’s Energy Plus software for more than 20 years.

- EnergyPlus 10x Challenge: LBNL
- EnergyPlus Whole-Building Modeling and Simulation Software Development: NREL
  - Lixing Gu, R. Raustad, B. Nigusse
Current Contracts

- Lab Home Measurement of Space Conditioning Energy Use with Flexible and Metal Duct Systems
- Survey of Unvented Attics in Climate Zones 2-3
- Estimating Internal Moisture Generation Rates in Occupied New Homes
- Energy and Sustainability Analysis for UF Public Safety Complex

Associated Gas Distributors of Florida
- Updating AGDF Model Costs and Equipment
- Reliability Evaluation of Bifacial and Monofacial Glass/Glass Modules with EVA and Non-EVA Encapsulants
- Advanced Vehicle Technologies Research
- Solar Feasibility Assessment Request for Quote
Current Contracts

The Levy Partnership
- [Sub-Award] Maximizing the Effectiveness of Ductless Heat Pumps in Existing Homes by Demonstrating Integrated Controls
- Technical Support

Sandia National Laboratories
- PV Lifetime Hot and Humid Climate Flash Testing

SEI Associates
- Trane Trace 3D Plus Software Development Support

Tactical Energy
- Comparison of Real World Assisted Living Buildings with a Baseline Models

NSF
- Enabling large-scale adaptive integration of technology hubs to enhance community resilience through decentralized urban food-water-energy nexus decision

RESNET
- SRCC Portal Development

FSEC Energy Research Center
A Florida Fable

“The Foreign Fuel”
A Priority For Florida’s Future

Spend Little to No funds on Imported Primary Fuels

• Utility and rooftop solar, hydrogen and battery energy storage, smart-charging electric vehicles (V2G), building energy efficiency improvements, and demand response are all needed and must be optimally integrated to achieve 100% renewables.

• To cost-effectively achieve 100% renewables, both utilities and customers (those on each side of the electric meter) must be empowered.

• Energy Resiliency for Consumers is an outcome from on-site solar and energy storage, as well as a hardened grid.
Solar Must Have Storage

Size and discharge durations by storage technology

- Months: Hydrogen, Pumped hydro
- Weeks: Compressed air energy storage
- Days: Sodium-sulfur batteries, Flow batteries
- Hours: Flywheels, Lithium-ion batteries
- Minutes: Super capacitor
- Seconds: Electrical, Mechanical, Electrochemical, Hydrogen-related

Source: Bloomberg New Energy Finance. Note: system capacities and discharge durations are based on general use, rather than technical limitations.
A New Energy System in 2070 (taken from Shell Sky)

The scale of global change in Sky is unprecedented.

2010
- Paris Agreement reached
- Global electric vehicle production

2020
- Global electricity consumption reached 33,000 TWh/year, having increased by 40% over the past decade

2030
- Global electric vehicle penetration
- Accelerated transition to clean energy
- First commercial hydrogen flights
- Global climate targets

2040
- Solar PV surpasses coal as the largest energy source
- Majority of trucks powered by electricity or hydrogen

2050
- Global energy systems on 100% RE per year (double 2010)
- Biofuel availability
- First widespread use of liquid fuels

2060
- Global cumulative storage of CCS exceeds the tonnage of emissions
- India and China each reach 10% of CCS per year stored

2070
- CO2 emissions reach 10.245 per year
- Net deforestation ceases to an end

2080
- Action plans developed in G7+ China to reduce emissions by 2030

2090
- Energy system CO2 emissions 0 Gt/year

2100
- Last countries to reach zero CO2 emissions

The graphics illustrate the transition from a fossil fuel-based energy system to an electric-based energy system, highlighting key milestones and changes anticipated by 2070.
New Contract Integration Example

Demonstration of Integrated Hydrogen Production and Consumption for Improved Utility Operations

Orlando Utilities Commission
Utility Co/Solar Integration/FC Vehicles

General Motors
Stationary Fuel Cell Systems

OneH2
Storage, Compression and Dispensing

UCF-FSEC
Techno-Economic Analysis, Solar to H2 Optimization

Giner ELX, Inc.
Electrolyzer System Development and Assembly
Demonstration of Integrated Hydrogen Production and Consumption for Improved Utility Operations

Integrated Hydrogen Production and Consumption for Improved Utility Operations

Project Objectives

- Develop integrated system incorporating PEM-based electrolysis for H₂ production/storage and H₂-fuel for refueling of FCEVs
- Electricity generation with site-specific PEM-based stationary fuel cells
- Develop/Optimize dispatch models based on grid-level optimization controls

Impact

- Deployment of Grid-Integrated Hydrogen assets creates a system capable of leveraging intermittently available low-cost electricity to produce hydrogen for use in FCEVs, back-up power, and grid operational use cases
- Ensures that the hydrogen is produced at the lowest electricity cost, and then consumed for the greatest possible value
- Develops business models for OUC or other utilities, where the utility provides both electricity and hydrogen fuel, either as a grid asset of to support the transportation sector

Diagram of Integrated H₂-Grid Asset

Partners

- Orlando Utilities Commission (OUC)
- General Motors
- OneH2
- UCF-FSEC
- Giner ELX, Inc.

- Utility Co. / Solar Integration / FC Vehicles
- Stationary FC Systems
- Storage, Compression, & Dispensing
- Techno-Economic Analysis, Solar to H₂ Optimization
- Electrolyzer System Development & Assy
Demonstration of Integrated Hydrogen Production and Consumption for Improved Utility Operations

Background

Hydrogen Offers a Green Solution to Intermittent renewables
- Rapid implementation of solar has led to storage needs more quickly than anticipated
- Solution: PEM Electrolyzer with fast response time, and be scalable to TWh
  - Electrolyzers can provide grid services & renewably generated hydrogen for mobility with fast response time as a controllable load
- Development of Hydrogen Markets are needed

OUC, No. 1 in reliability since 1998²
- OUC’s solar penetration is <1%, but increasing rapidly to 20% by 2022, plans to integrate 40% solar by 2024+

The “California Duck” Chart:
Non-solar generation required over a 24-hour period (2012 to 2020)

Sources:¹ CAISO. ² Florida Public Service Commission. ³ OUC.
Demonstration of Integrated Hydrogen Production and Consumption for Improved Utility Operations

Proposed Equipment Layout

- Connection to OUC Grid
- Existing 32 kW Floating Solar Array
- New 750 kVA transformer
- 510 kW Electrolyzer
- 3 x 70 kW Fuel Cells
- Hydrogen Storage
Technology Summary

- A pre-packaged retrofit solution targeting 75% reduction in space conditioning and water heating energy.
- Integrates highly efficient heat pump water heater and mini-split heat pump, both directly powered by an off-grid system of PV and newly developed micro-inverters.
- Grid energy can assist when PV resources are low, and excess PV can be stored in a battery.

Key Personnel

Carlos Colon – FSEC
Jeff Sonne – FSEC
Ankur Maheshwari – Rheem

Key Milestones & Deliverables

<table>
<thead>
<tr>
<th>Phase</th>
<th>Key Milestones &amp; Deliverables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 1</td>
<td>• Proof of concept including achievement of energy savings goals.</td>
</tr>
</tbody>
</table>
| Phase 2 | • Complete enclosure design and fabrication w/ Rheem.  
|        | • Demonstrate on 5 occupied homes. |

Technology Impact

- Coupling current state-of-the-art with new innovations is expected to result in achievement of the 75% target energy use reduction.
- When scaled, this exceeds 1,800 Tbtu of total technical potential when applied to housing stock in all climates except very cold.
UCF Energy Initiative

Winston V. Schoenfeld
Director, Solar Technologies Research Division, FSEC
Energy Blue-Ribbon Panel

- Panel comprised **15 members** (UCF and external)
- Generated **32-page report** with many recommendations:
  - Create a *university-wide coordinating unit* around energy
  - Evaluate current and future *energy-related courses and curriculum*
  - Better market UCF energy research
  - Identify/Obtain support for a UCF-wide center/institute for research and education in energy and enhanced university/industry research opportunities
  - Identify faculty needs to better integrate energy across campus

UCF Energy Initiative
GOAL: Unified effort to become leader in Energy Research and Education

- Coordination of Energy Efforts across UCF
- Prioritize broad initiatives to strengthen UCF Energy Ecosystem
- Leverages existing Centers and Clusters
- Guidance from two key councils
- Put sustainability concepts to practice on UCF campuses
Energy Education

- EnergyWhiz & Celebration of 50th Anniversary of Earth Day
  April 25th, 2020

- Our Partners:
  - Eastern Florida State College
  - Parks & Recreation Brevard County
  - Space Coast Science Education Alliance
  - IDEAS for Us
  - Florida Department of Agriculture and Consumer Services
  - Space Coast League of Women Voters
  - FAU
  - Pine Jog Environmental Center

- Over 1000 participants expected
STEM Education: K-12 Teachers and Students

- EnergyWhiz Expos
  - Boca Raton
  - Brandon
  - Tallahassee

- Student Groups
  - 4th grade to college level
  - Over 1000 students

- Teacher Workshops
  - Solar Schools, Hydrogen, Solar Cookers, Photovoltaics

- Presentations, Special Events and Other Outreach
  - STEM focused
  - Over 30,000 students
  - Curriculum Kits
Vision Statement
Promote the rapid transition to a sustainable energy economy through renewable energy and energy efficiency research, demonstration, and education.

Mission Statement
Develop, research, and evaluate energy technologies that enhance the environment and economy, and transfer the results to the public, students and practitioners.
Advisory Board Partners
Advisory Board Partners

Energy Consumers
- Publix
- City of Orlando
- Health First
- Universal Orlando Resort
- ACES
- Brevard Public Schools

Builders
- Lifestyle Solar-Powered Homes
- Palm Harbor Homes
- C.T. HSU + ASSOCIATES, P.A.
  Architecture • Planning • Interior Design

Electric Utilities
- Duke Energy
- FMPA Municipal Power
- FPL Gulf Power
- OUC
- TECO Energy

Manufacturers
- Mitsubishi Electric
  Cooling & Heating
  Transforming The Process Industries
- RAPID

Associations/Government
- Smart Electric Power Alliance
- Central Florida Clean Cities Coalition
- Drive Electric Florida
- UCF
Questions?
Solar Power

Florida’s Fuel for Electric Cars

https://vimeo.com/channels/fsec/26289868
SUBMITTED PROPOSALS PENDING
Submitted Proposals PENDING


- PV Module Testing for Degradation – Next ERA – $154,000

- Dynamic Adaptive Protection for Self-Healing Distribution Grids with High PV Penetration- University of CO/Denver - $720,000

- Photovoltaics for Primary and Secondary Schools - Directorate of Urban Administration & Development, M.P., Bhopal - $686,972
Submitted Proposals PENDING (Cont’)

• PV-GEMS: Photovoltaic Powered, Grid Enhanced Mechanical Solution. A pre-packaged approach providing high efficiency and resilient space conditioning, and water heating - US DOE - $617,076, E. Martin, C. Colon, J. Sonne

• Reimagining HVAC for New Manufactured Housing - Slipstream Group - $468,750


• SunSmart Schools E-Shelter Maximization Project – Phase 1 - FLDACS - $118,667
Submitted Proposals PENDING (Cont’)

• The Use of Solar Concentrated Power to Drive a Modified Kvaerner Process to Make Hydrogen and Carbon Black from Organic Matter - University of Applied Sciences Technikum Wien - $248,943

• Identifying Durability Bottlenecks in Carrier Selective Heterostructures to Inform the Evolving Si Technology Pathway - Case Western Reserve University - $62,530

• Dynamic Control of Autonomous Grid-Forming PV Inverters with Enhanced Resiliency and Stability - Univ. of Houston - $807,987

• Residential Buildings Subject Matter Expert Technical, Outreach and Research and Development Support - NREL - $30,000, E. Martin, J. Sonne, J. McIlvaine