

The State of FSEC

James Fenton

Advisory Board Meeting

October 19, 2018



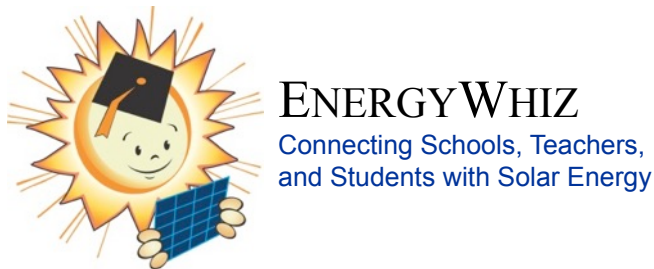
**FSEC Energy
Research Center**

UNIVERSITY OF CENTRAL FLORIDA

FSEC Advisory Board Meeting AGENDA

10:00 a.m.	Welcome and Introductions	Mike Faas, Chair
10:10 a.m.	Approval of March 30, 2018 Meeting Minutes	Mike Faas, Chair
10:15 a.m.	Status of FSEC Programs	Jim Fenton
10:30 a.m.	National, States, and Florida State and Cities Energy Policy Report of Florida Energy Office	Louis Rotundo Kelley Smith Burk
11:00 a.m.	FSEC Energy Research Center Website	Sherri Shields
11:20 a.m.	Clean Cities (Alternative Fuel Transportation)	Doug Kettles
11:40 a.m.	PV and Energy Storage	Adam Nygaard CHP, Microgrids, & Energy Storage Development Duke Energy – Distributed Energy Technologies
12:10p.m.	Lunch (Buffet)	
1:00 p.m.	City of Orlando Energy Update Smart Energy Innovation Network (Orlando/OUC/FSEC/NREL/RMI)	Chris Castro
1:15 p.m.	Floating Solar in Florida	Stetson Tchividjian, Business Development Manager D ³ energy
1:45 p.m.	Board Business <ul style="list-style-type: none"> ▪ Date and Agenda for Next PAB Meeting ▪ Future Board Activities (FSEC Vision for Next Five Years) 	Mike Faas, Jim Fenton

Collaborative Partnerships



PV, EVs, Energy Efficient Buildings, Load Management, Batteries, Alternative Fuels, Hydrogen, Fuel Cells, Smart Grid Electronics, V2X, Training & Education

New Contracts

- **U.S. Department of Energy** – Continue to develop and support users of the Energy Department’s Energy Plus software.
Dr. Lixing Gu, Rich Raustad and Dr. Bereket Nigusse
- **Orlando Utility Commission** – Evaluate and make recommendations on a number of customer efficiency efforts by evaluating data from current programs, as well as estimating impact from new programs.
Rob Vieira, Rich Raustad, Danny Parker and Karen Fenaughty
- **National Science Foundation** – Belmont Forum Collaborative Research Food-Water-Energy Nexus: Enabling adaptive integration of technology to enhance community resilience.
FSEC’s Dr. Lixing Gu and Deputy Director Philip Fairey, two of five UCF research investigators for the project

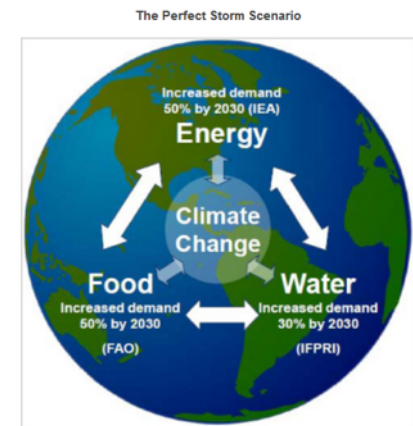
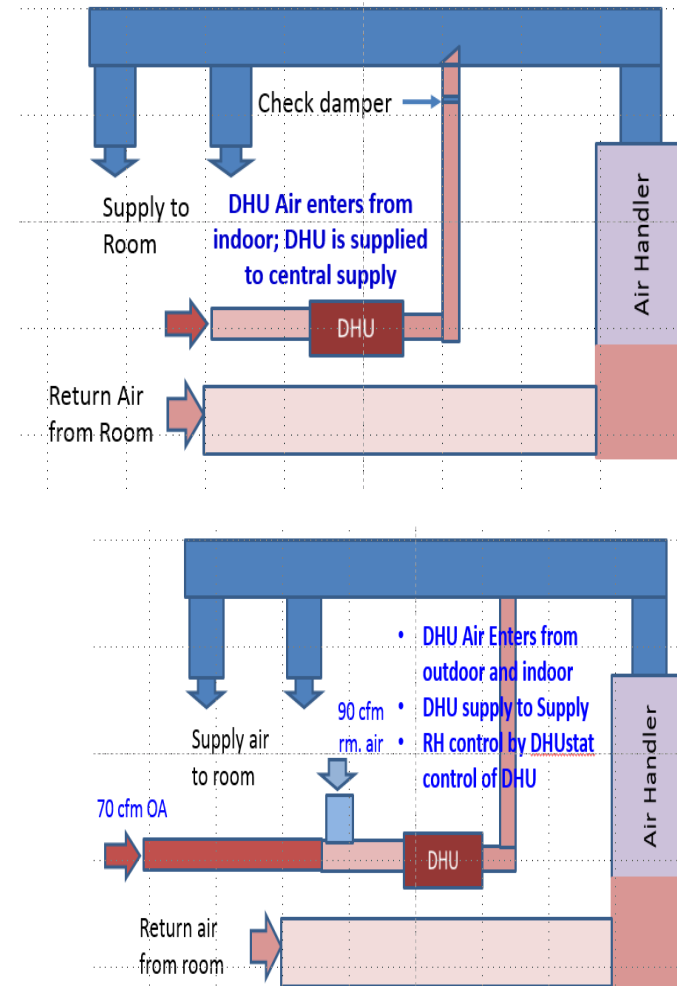


Image Source: waternexussolutions.org and BIS

New Contracts:

State Department of Business and Professional Regulation for the Florida Building Commission

- Residential Attic Performance Comparison Research (Lab)
– *Chuck Withers, PI*
- Quantitative and Economic Analysis of the 7th Edition Florida Building Energy Code (Analysis)
– *Dr. Bereket Nigusse, PI*
- Ducted Dehumidifier Location – Using Dehumidifier as Dedicated Outdoor System (Lab)
– *Chuck Withers, PI*



Lawrence Berkeley National Laboratory

Residential Appliance Monitoring

- **New Contract Received, Not Yet Signed**
- Goal: Determine typical use of the following residential appliances for standards development:
 - Stovetops, ovens, dishwashers, refrigerators, microwaves
 - Washing machines, dryers
 - Portable air conditioning systems, portable dehumidifiers
- Methodology
 - FSEC will monitor homes in two Berkeley Lab-selected cities
 - Central logger, remote loggers
 - Homeowner will keep logs of use of each appliance
- FSEC Team
 - *Carlos Colon, Dave Chasar, Danny Parker, Rob Vieira*



Pending DOE-Funded Industrial Collaborative Partnerships



- Investigation of the Prevalence and Energy Impacts of Residential Comfort System Faults – Hot Humid and Hot Dry Climates – *Eric Martin, Danny Parker, Chuck Withers, Dave Chasar*
- Evaluating Hybrid Whole-House Ventilation Systems in the Hot Humid Climate – *Jeff Sonne*
- Transitioning to Market Driven Residential Energy Codes – *Philip Fairey, Rob Vieira, Jeff Sonne, Janet McIlvaine, Danny Parker*

Pending DOE-Funded Industrial Collaborative Partnerships



- Quantifying and Valuing Fundamental Characteristics and Benefits of Floating Photovoltaic Systems – *John Sherwin*
- Establishing an Integrated Solar Workforce Development System – *Colleen Kettles*
- More Durable PV Systems Through Finite Element Modeling of Mounted Modules that Accurately Captures Complex Interactions Between Components – *Hubert Siegneur*
- Unlocking Diversified Applications of UV Ozone Oxide for High Efficiency Passivated Contact MIS Silicon Solar Cells and Beyond – *Ngwe Zin*
- Microdroplet Electrospray Localized Laser Printing and Sintering of Nanoparticles for Passivated, Carrier-Selective Contacts – *Kris Davis*
- Silver-Free Multi-Wire Metallization of Solar Cells using Transparent Conductive Polymers and Copper Grids – *Kris Davis (Co-PI)*



Pending Contracts

- **ASHRAE** – Add on to current Building America work to investigate moisture generation in residences (in negotiation).
Eric Martin, Chuck Withers
- **Air Distribution Institute** – Investigate flexible vs. metal duct work energy impacts in residences (in negotiation).
Eric Martin, Chuck Withers
- **American Chemistry Council** – Continuation of investigating moisture in roof decks of sealed attics. *Eric Martin, Chuck Withers*
- **NYSERDA through LEVY Partnership** – Optimize controls for supplemental mini-split heat pumps for heating applications,
Eric Martin, Karen Fenaughty, Danny Parker





ENGINEERING RESEARCH CENTER FOR ENERGY STORAGE SYSTEM ENABLED SOCIETY (ESSENSE)

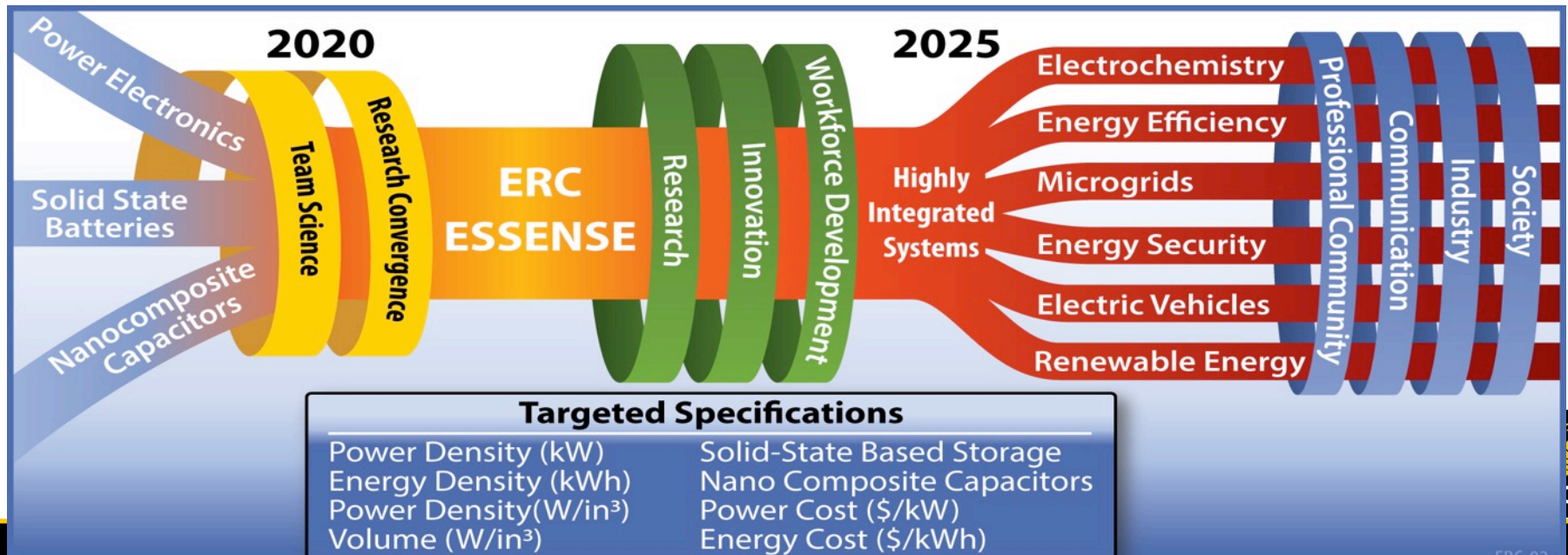
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NSF ERC Planning Grant: One-Year project to develop full proposal under the Engineering Research Center. Total Funds: \$100K

Main Theme: The ESSENSE center will create innovative technological solutions and will lay the foundation for achieving affordable, clean, resilient, and secure electric energy sources to the benefit of society.

ESSENSE will explore the following technical areas:

- (1) Solid State Batteries
- (2) Nanocomposite Capacitors,
- (3) Wide-Band Gap Power Devices
- (4) Integrated Power Electronic and Electric Storage for Grid-tied Application.





NSF GOALI: HIGHLY INTEGRATED GRID-TIED MULTI-PORT POWER MODULE FOR PV AND STORAGE

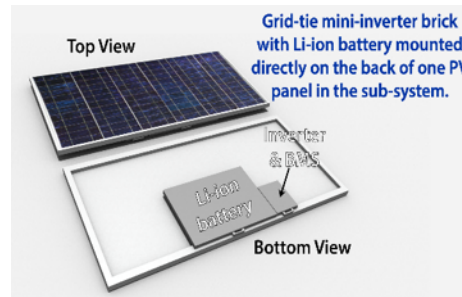
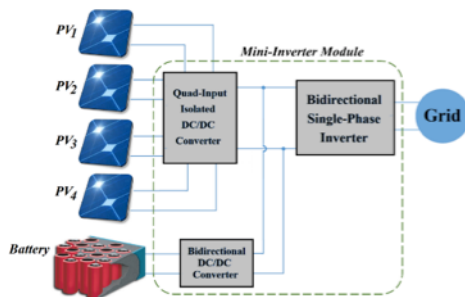
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NSF Goal Program:

- Three-year project in collaboration with UCF, FSEC and AllCell Technologies
- Total Funds: \$360K
- Design and build highly-integrated PV, Battery and Power Electronics

Anticipated Outcomes:

- Conduct thorough analysis and design procedure on the proposed new quad-input converter in terms of efficiency, power density and cost
- Design and simulation of a 1.2 kW quad-input DC/DC converter and a 1.2 kW buck/boost bidirectional battery converter.
- Carry out prototyping and testing tasks for the proposed 1.2kW, 4 PV panel with 1.2 kW energy storage.



Broader Impact:

- The proposed system will:
 - Enable greater penetration of PV into the electric grid
 - Expand worldwide use of solar energy
 - Stimulate the entire PV industry
 - Create employment opportunities
 - Lead to lower energy costs.
- Micro-storage-based system will:
 - Provide a reliable, renewable energy asset for the grid
 - Reduce the nation's dependence on fossil fuels
 - Result in environmental and economic benefits
 - Creating a grid that is more resilient to outages.
- In the next decade, such technological integration of hardware and software, seamlessly interconnected, and easily expandable, will:
 - Become cost effective
 - Open the way for even greater PV penetration
 - Result in accelerated PV deployment through simplified installation processes and increased value to the consumer.



“Facilitating the adoption of alternative fuel vehicles as a petroleum reduction strategy”

National Meeting at FSEC November 6-8, 2018

- **All Clean Cities Coalitions, US DOE and National Lab program managers, DOE Vehicle Technologies Office Director in attendance**
- **Welcome Reception Nov. 6 at Port Canaveral Exploration Tower**

UCF Energy Initiative



- Prof. Winston V. Schoenfeld appointed Director
(Also serves as FSEC Director Solar Technologies Research Division)
- Blue-Ribbon Panel
 - 15 members (internal and external)
 - Created January 2018
 - Encompasses FSEC, Facilities, Energy Faculty Clusters (2), Engineering and Science departments
 - Focus: Identify how UCF can create a unified effort to become a leader in Energy Research and Education
 - Panel assembled a 32-page report outlining several recommendations for UCF
- http://www.research.ucf.edu/documents/PDF/UCF_BlueRibbonEnergyPanelFinalReport.pdf

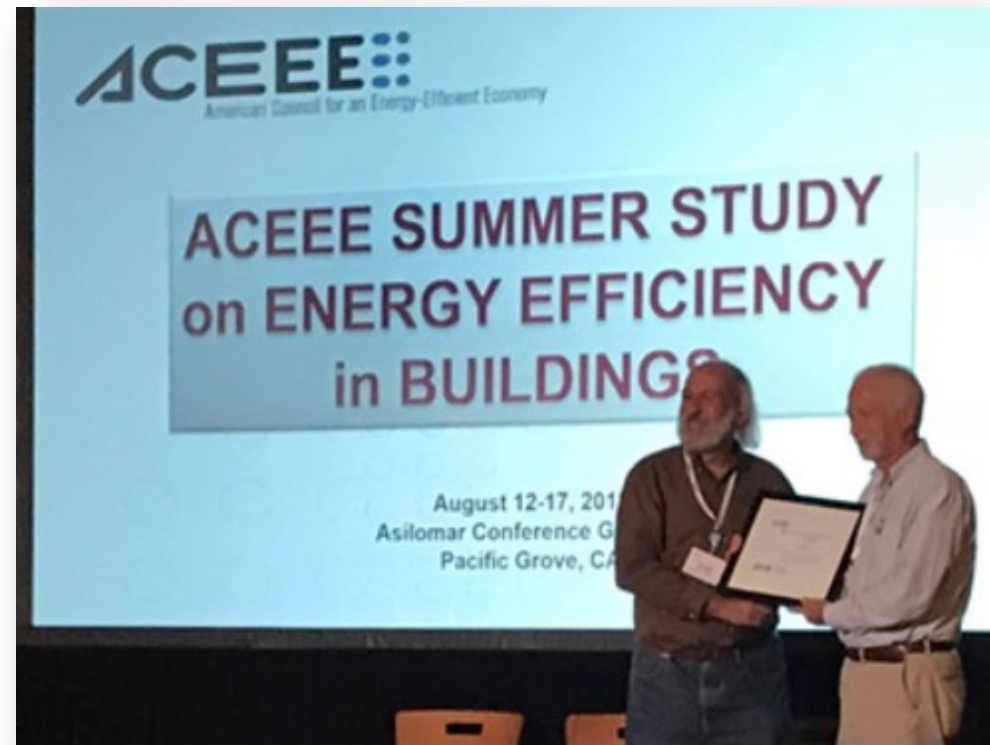
Key Panel Recommendations

- UCF energy community should receive clear vision and direction from UCF leadership
- Create a university-wide coordinating unit around energy
- Evaluate current and future energy-related courses and curriculum
- Market UCF energy research
- Obtain legislative support for a center/institute for research and education in energy and enhanced university/industry research opportunities
- Identify faculty needs in economics and policy needed to integrate energy across campus

**** Panel report details each of these with multiple action items*

Danny Parker Receives Prestigious ACEEE Champion of Energy Efficiency in Buildings Award

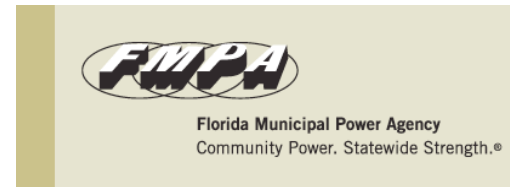
- Danny Parker was recognized “for his systematic examination of building energy through more than 35 years of laboratory, field, and simulation studies and for his development of new home products and deep retrofits. His work is documented in more than 150 peer-reviewed papers and has received 2,500 citations.”



Partners



C.T. HSU + ASSOCIATES, P.A.



R&D Partnerships

FSEC Offers

- Holistic and integrated approach for new and emerging energy systems (PV, Storage, EVs and Buildings)
- Real world performance, analysis and durability

Benefits

- Response moves from reactive to proactive
- Provides deeper insight into field performance
- Improved LCOE of an energy system
- New market opportunities through integration of multiple energy systems
- Aids grid integration of new energy systems

Questions?



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EXTRA SLIDES

Opportunities

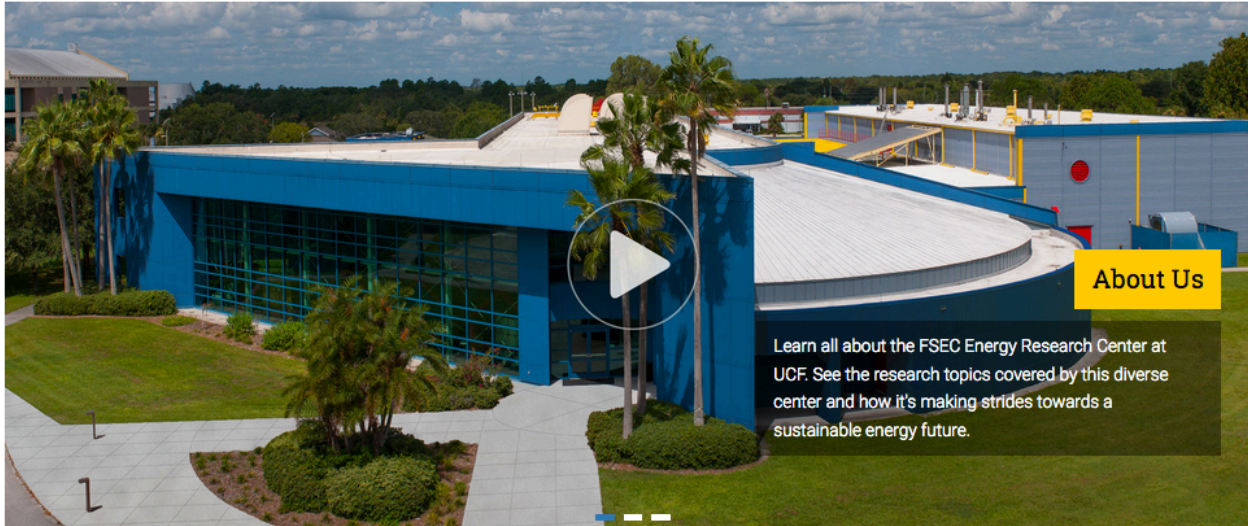


- Power and Energy Readiness for Robotic and Autonomous Systems: UCF, Army, GM, Protonex and Proton Energy
- National Science Foundation: Engineering Research Center (NSF ERC)
- Collective Impact : Orlando Affordable Housing
- UCF Blue Ribbon Energy Panel: Encompasses FSEC, Facilities, two Energy Faculty Clusters, Engineering and Science departments

FSEC Energy Research Center

A Research Center of the University of Central Florida

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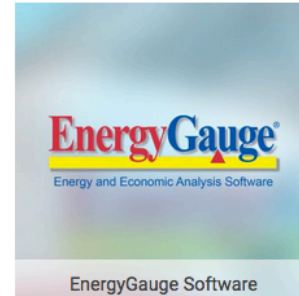
Building Science Laboratory



EnergyWhiz



Continuing Education



EnergyGauge Software

The Energy Research Center

UCF Today



Smart Vent Tech Improves IAQ and Saves Money, Energy

By Jennifer Josey National Renewable Energy



Energy-Research Meeting Seeks Research Ideas

Have some ideas about what UCF should be exploring in the area of energy research? Then plan

Orlando: Renewable and Resilient

- City of Orlando: 100% renewable energy for *municipal* buildings by 2030, 100% citywide by 2050.
- Investigate approaches for deploying photovoltaic (PV) and PV plus storage to increase resiliency of municipal operations and electric grid.
- Partnership:
City of Orlando, Orlando Utilities Commission (OUC), National Renewable Energy Lab, Rocky Mountain Institute, UCF'S FSEC
- Funded by: U.S. DOE, Solar Energy Innovation Network



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Solar Energy Innovator Program

- Department of Energy is funding UCF's Dr. Paul Brooker to carry out research at OUC on innovative solutions to the challenges faced by electrical utilities, energy service providers, and electric public utility commissions as solar energy and other distributed energy resources increase on the electrical grid.



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Transition



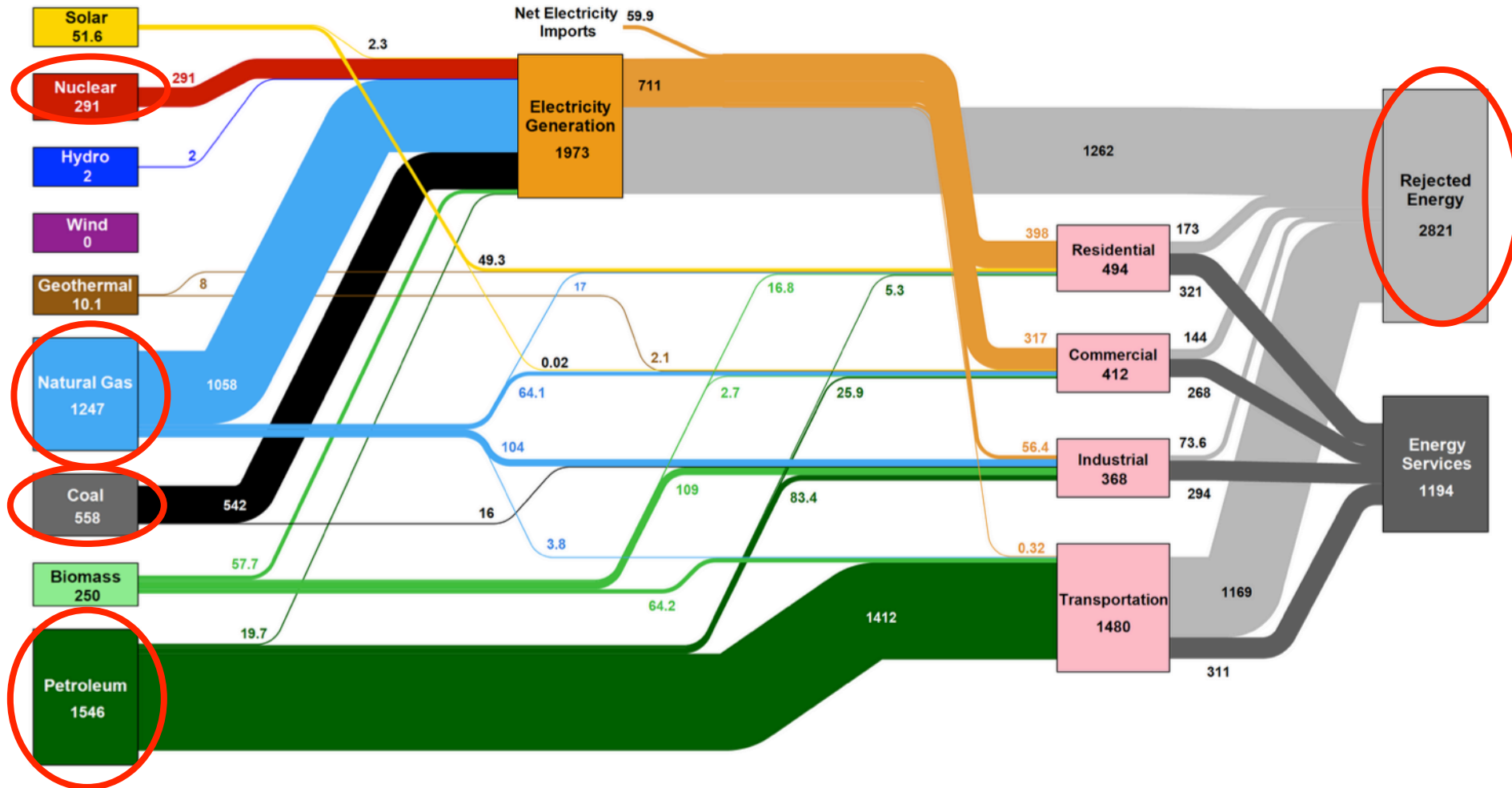
- Driven by DOE solicitations to **Industrial-Funded Collaborative Partnerships**
 - Value-added research for utilities, diverse state and federal agencies, manufacturers of energy-saving technology and industries that process and consume energy
 - Working groups that cooperatively steer FSEC into carrying out collaborative research that provides funding for FSEC researchers and is beneficial to the members of the Working group [Win-Win]
 - Opportunities with EV/PV/Energy Storage RD&D

Florida spent \$56 Billion on Energy

70% of primary energy is wasted!

(Almost all from imported coal, oil, gas and nuclear)

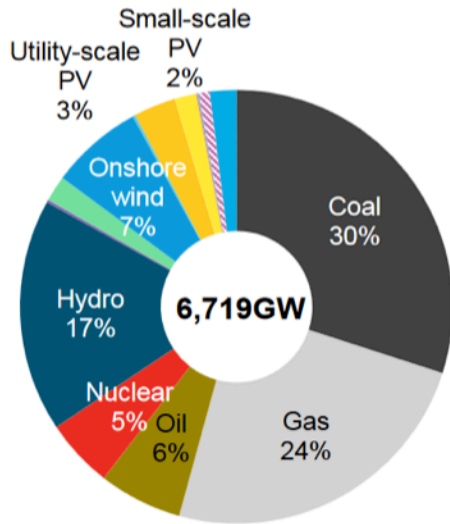
Florida Energy Consumption in 2014: ~ 4015 Trillion BTU



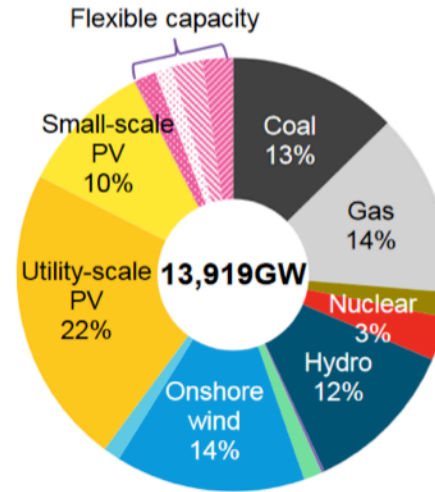
Source: LLNL July, 2016. Data is based on DOE/EIA SEEDS (2014). If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports consumption of renewable resources (i.e., hydro, wind, geothermal and solar) for electricity in BTU-equivalent values by assuming a typical fossil fuel plant heat rate. The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 65% for the residential sector, 65% for the commercial sector, 80% for the industrial sector, and 21% for the transportation sector. Totals may not equal sum of components due to independent Rounding. LLNL-MI-410527

Solar and wind dominate the future of electricity

Global cumulative installed capacity:
2016

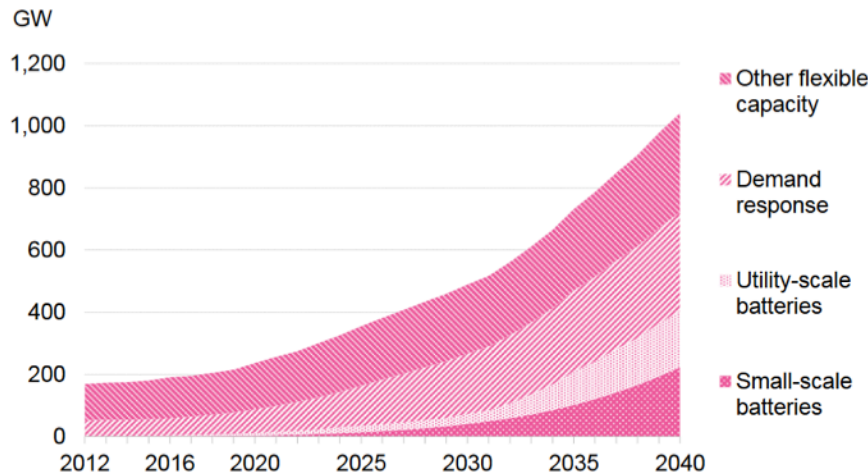


Global cumulative installed capacity:
2040



Source: Bloomberg New Energy Finance, *NEO 2017*

Demand response and batteries meet peak and balance the grid

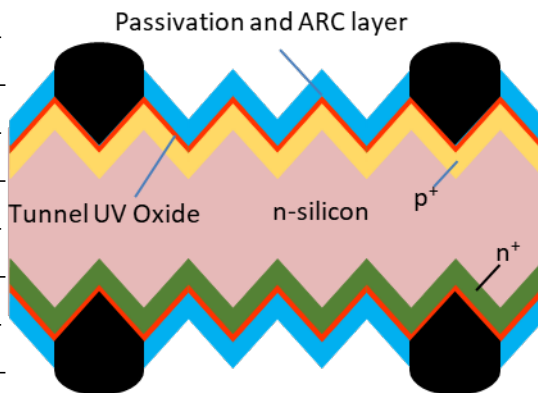
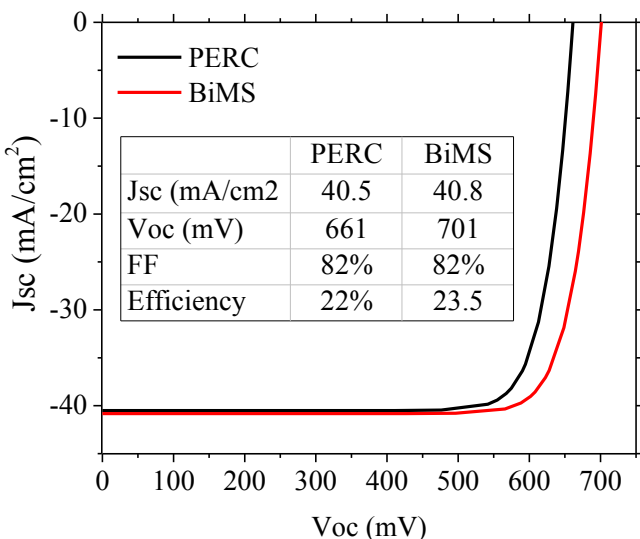
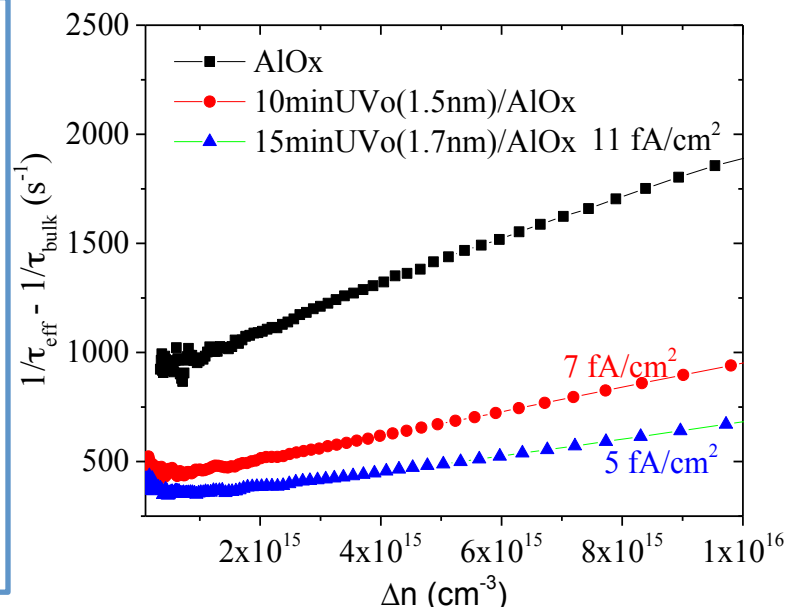


Top 5 markets in 2040	
China	343GW
U.S.	200GW
India	127GW
Japan	62GW
Germany	30GW

Pending DOE Solar FOA (Bifacial PV Cell)

Project Tasks:

- Demonstrate UV-ozone as an effective clean comparable to RCA clean quality on different surface morphologies
- Demonstrate bifacial MIS cell efficiency at STC of $\geq 23.5\%$ obtained with a UV-ozone as passivation and current tunneling contact on a lab-scale cell.
- Develop bifacial MIS cell with efficiency at STC of $\geq 23.5\%$ with a manufacturing process ready for the technology transfer to the PV manufacturer.

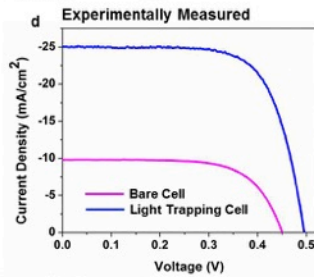
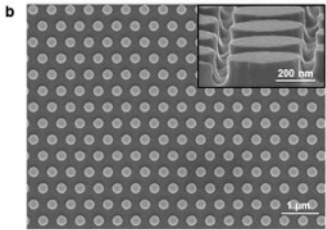
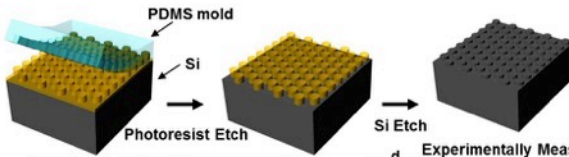


Partners:

- Georgia Institute of Technology
- GCL System Integration
- Solar Energy Research Institute of Singapore
- NAURA-Akrion
- SolarTech Universal

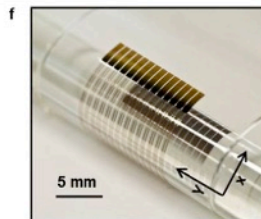
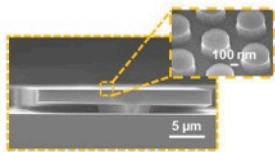
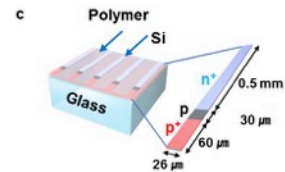
Pending DOE Solar FOA (Light Trapping)

a Soft Nanoimprint Lithography



e Experimentally Measured

Case	J_{sc} (mA/cm ²)	V_{oc} (V)	FF (%)	η (%)
Bare Cell	9.62	0.45	71.1	2.9
Light Trapping Cell	24.57	0.494	71.5	8.47



Project Tasks:

- Develop a light trapping scheme that maximizes angle and wavelength independent photon absorption
- Develop an electronic device architecture that maximizes carrier collection
- Develop the nanoimprinted LT scheme, incorporating thin wafers ($\sim 150 \mu\text{m}$) to drive the module price of $\leq \$0.25/\text{Wp}$ and LCOE of $\leq \$0.03/\text{kWh}$

Partners:

- University of Illinois
- King Abdullah University of Science and Technology

More Durable PV Systems Through Finite Element Modeling of Mounted Modules That Accurately Captures Complex Interactions Between Components

DR HUBERT SEIGNEUR / UNIVERSITY OF CENTRAL FLORIDA (UCF)

Project Summary

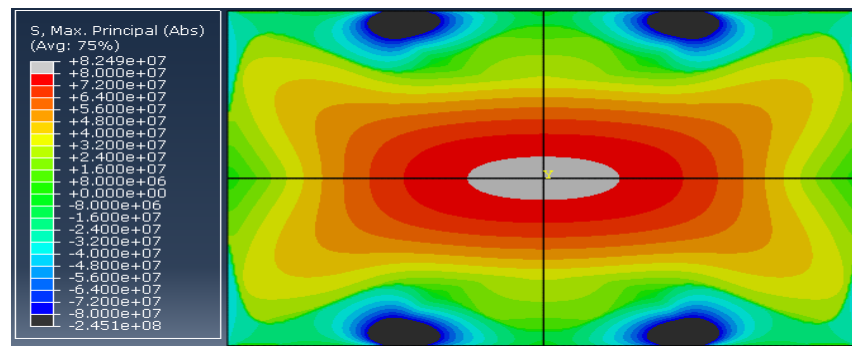
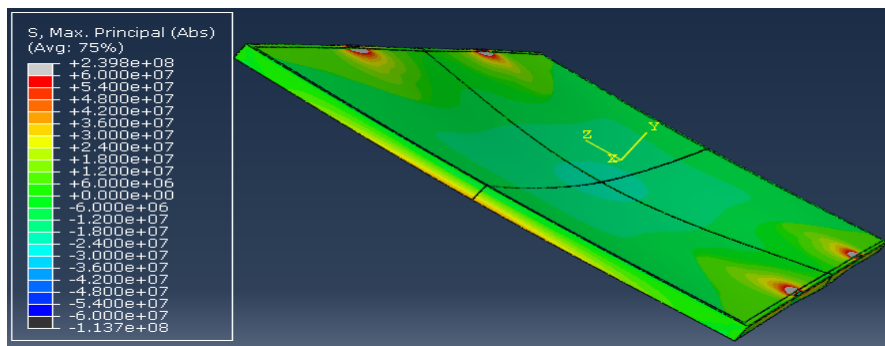
A critical problem for the PV industry is that many existing designs of solar panels and mounting schemes/hardware together with installation and handling methods place the cells into high stress states where they crack. Finite element (FE) modeling can play an important role in mitigating the formation and/or opening of cracks. However, existing models aren't very accurate (computed stresses can easily diverge more than 50% depending on assumptions) and remain inaccessible to most groups, and there is little good guidance from the literature. We aim to change that.

Key Partners

Sandia National Laboratory
BrightSpot Automation LLC
D2 Solar
Tessolar Inc

Anticipated Impact

- (1) Improve LCOE because of better designs and/or introducing new solutions to old failure
- (2) Enable faster design cycles
- (3) Reduce risk in adopting new technologies
- (4) Enable cost savings and mass reduction
- (5) Improve best installation and handling practices



Junior Solar Sprint: Connecting Communities with Opportunities for Success



STEM Savvy
Educators

STEM Literate
Citizenry

Sustainable
Infrastructure



Pending DOE-Funded Industrial Collaborative Partnerships



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