The State of FSEC

James Fenton

Advisory Board Meeting

November 18, 2019

FSEC Energy Research Center

UNIVERSITY OF CENTRAL FLORIDA

FSEC IN THE NEWS

Florida Solar Energy Center
Published by Sherri Hornig Shields [?] · November 4 at 2:43 PM ·

UCF.EDU

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

349	52	
People Reached	Engagements	Boost Post

25 2 Comments 2 Shares

Florida Solar Energy Center
Published by Sherri Hornig Shields [?] · October 8 ·

FSEC in the news...

ORLANDOSENTINEL.COM

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

185	28	
People Reached	Engagements	Boost Post

5 2 Shares

UCF Research

Sherri

UCF

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UCF Research

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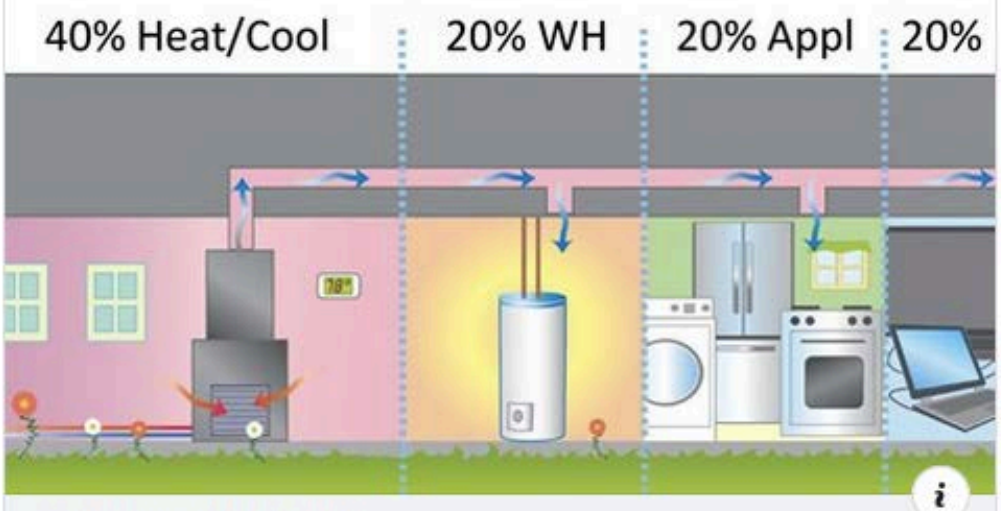
Posts

UCF Research

20 hrs ·

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/consu.../buildings/priorities/...



ENERGYRESEARCH.UCF.EDU

How to Reduce Energy Costs in Existing Homes – Priorities - FSEC Energy Research Center

1 Share

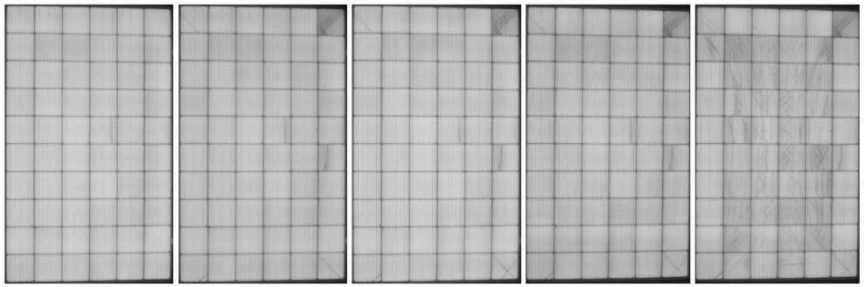
pv magazine

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

EVENTS | MODULES & UPSTREAM MANUFACTURING | QUALITY | TECHNOLOGY | TECHNOLOGY AND R&D | EUROPE | FLORIDA | WORLD



Microcracks develop under cold temperatures and pressure.

Image: University of Central Florida

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?

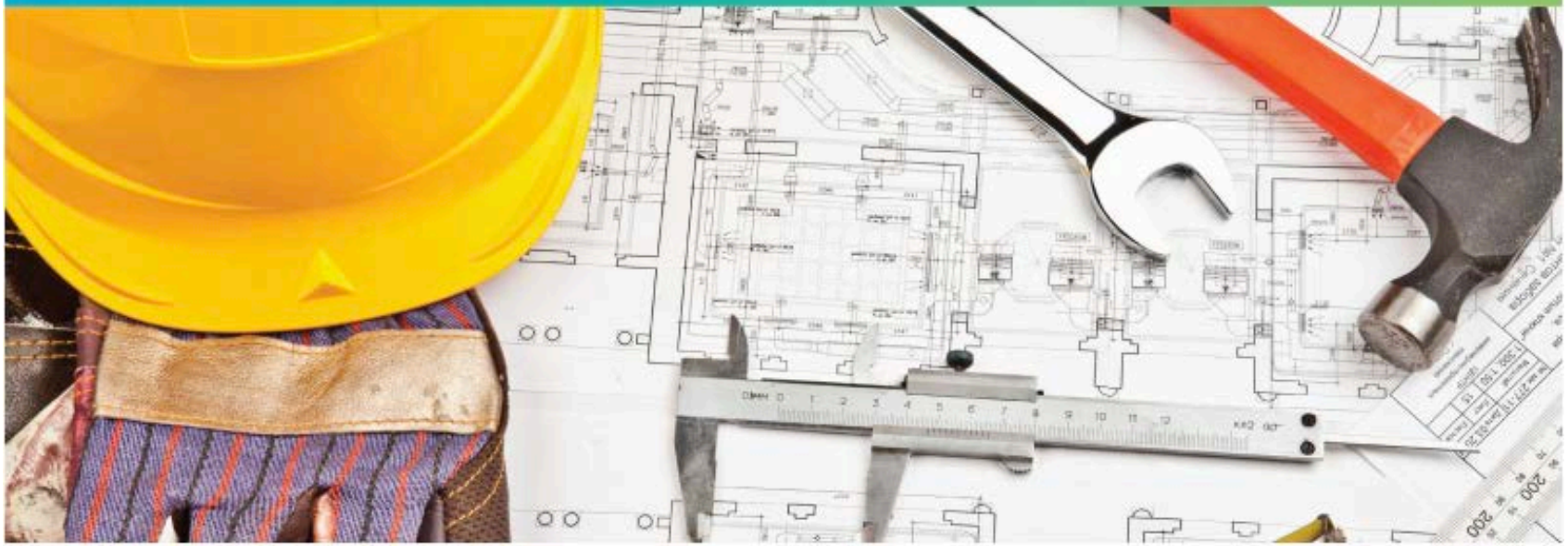
Eric Schneller, research scientist at the Florida Solar Energy Center institute of the University of Central Florida: The standard IEC sequence that aims to capture cell cracking involves cyclic mechanical loading followed by 50 thermal cycles and 10 humidity freeze cycles. We have implemented a modified 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.

UCF

2019 ENERGY STAR® CERTIFIED HOMES MARKET LEADER AWARD

The simple choice for energy efficiency.

ENERGY STAR



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

Building AMERICA
U.S. Department of Energy

H2@Scale
U.S. Department of Energy

CENTRAL FLORIDA CLEAN CITIES COALITION

SOLAR ENERGY TECHNOLOGIES OFFICE
U.S. Department Of Energy

EVTC
Electric Vehicle Transportation Center

SOLAR TRAINING NETWORK
POSITIVE CONNECTIONS. POWERFUL CAREERS.

Regional Test Centers
Differentiating PV Quality

First Responder Safety Training *for* Alternative Fuel Vehicles

DRIVE ELECTRIC FLORIDA

ENERGYWHIZ
Connecting Schools, Teachers, and Students with Solar Energy

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

CURRENT CONTRACTS

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*
- **Energy Codes: Comparing Performance in a Changing Technological Environment,** *P. Fairey, R. Vieira, J. Sonne, J. McIlvaine*

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

RESNET
RESIDENTIAL ENERGY SERVICES NETWORK

- Technical Support

Sandia National Laboratories

- PV Lifetime Hot and Humid Climate Flash Testing

ICC-SRCC
SOLAR RATING & CERTIFICATION CORPORATION

- SRCC Portal Development

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

UCF


A Florida
Fable
"The Foreign Fuel"

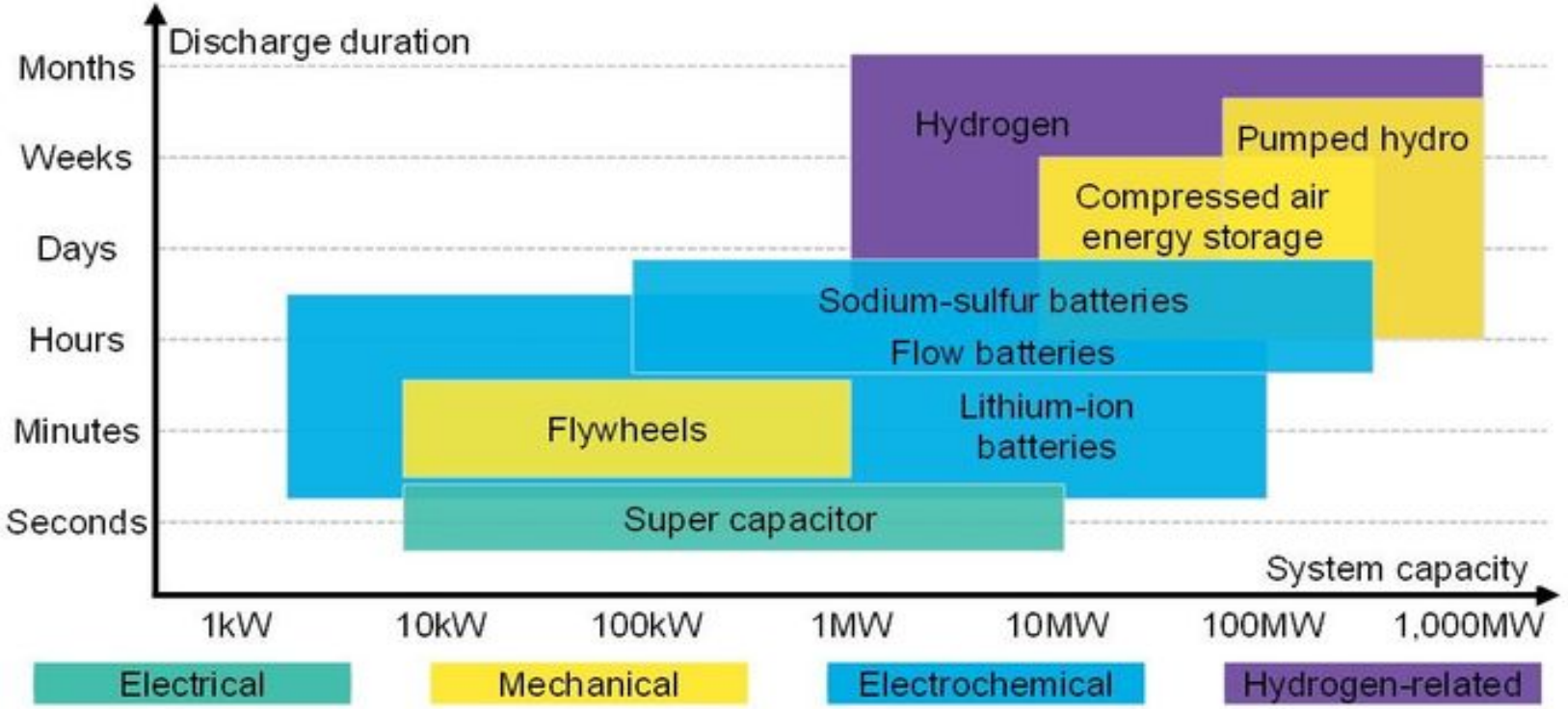
A Priority For Florida's Future

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.

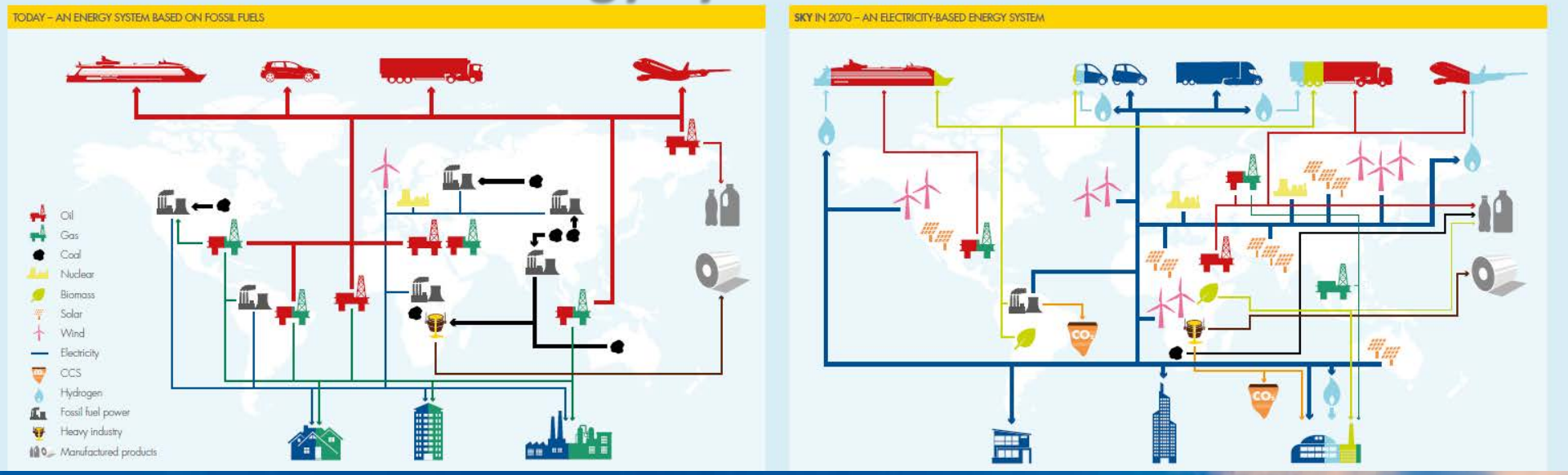
Solar Must Have Storage

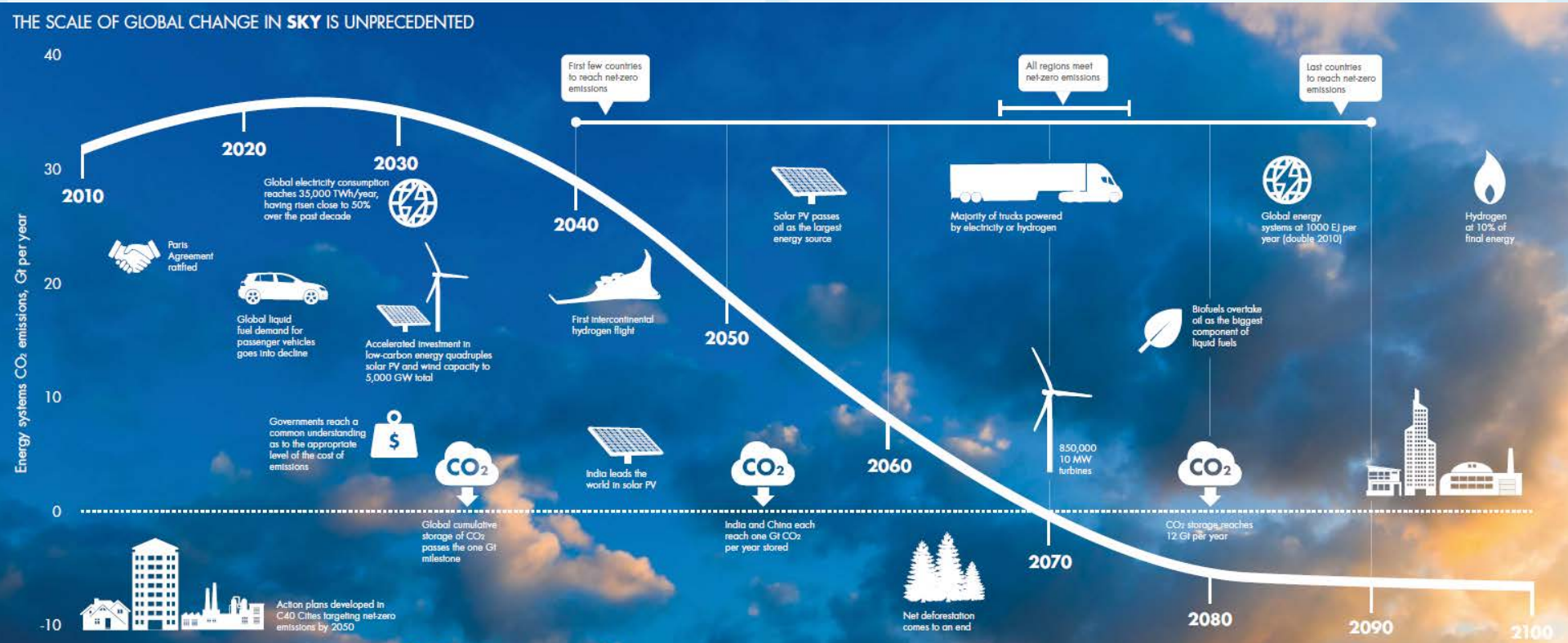
Size and discharge durations by storage technology



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)





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

GINER ELX

Project Objectives

- Develop integrated system incorporating PEM-based electrolysis for H_2 production/storage and H_2-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

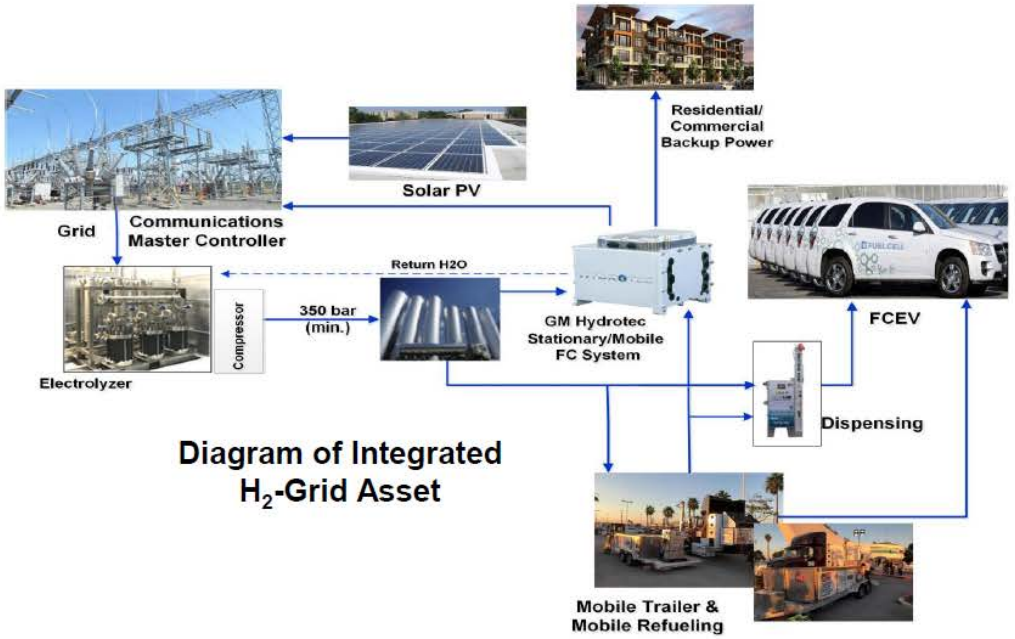


Diagram of Integrated H_2-Grid Asset

Partners

Orlando Utilities Commission (OUC) – Utility Co. / Solar Integration / FC Vehicles
General Motors – Stationary FC Systems
OneH2 – Storage, Compression, & Dispensing
UCF-FSEC – Techno-Economic Analysis, Solar to H2 Optimization
Giner ELX, Inc. – Electrolyzer System Development & Assy

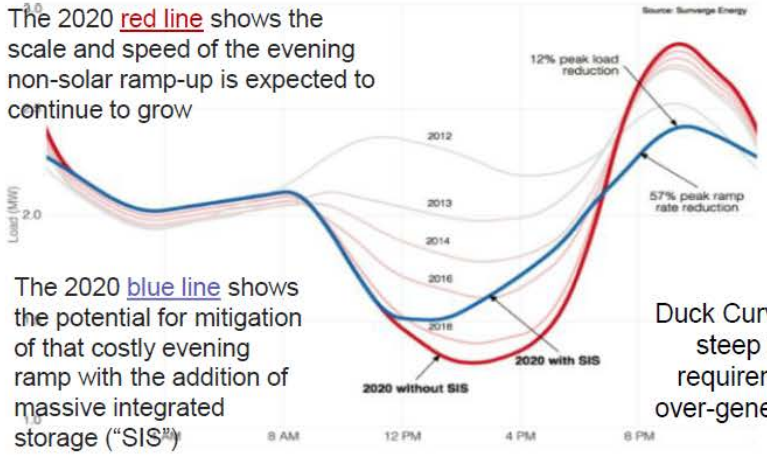
Demonstration of Integrated Hydrogen Production and Consumption for Improved Utility Operations

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

The 2020 red line shows the scale and speed of the evening non-solar ramp-up is expected to continue to grow



The 2020 blue line shows the potential for mitigation of that costly evening ramp with the addition of massive integrated storage ("SIS")

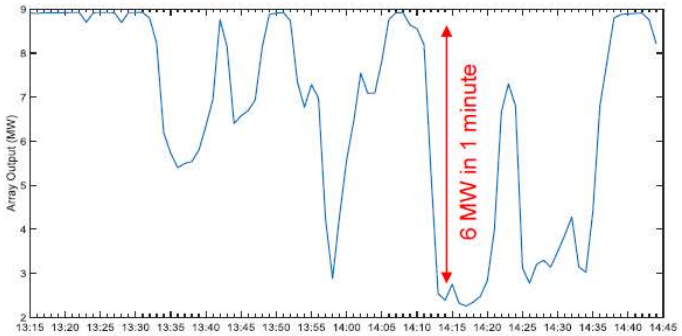
Duck Curve indicates steep ramping requirements and over-generation risk [1]

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

GINERELX

OUC The Reliable One®

- OUC, No. 1 in reliability since 1998[2]
- OUC's solar penetration is <1%, but increasing rapidly to 20% by 2022, plans to integrate 40% solar by 2024+



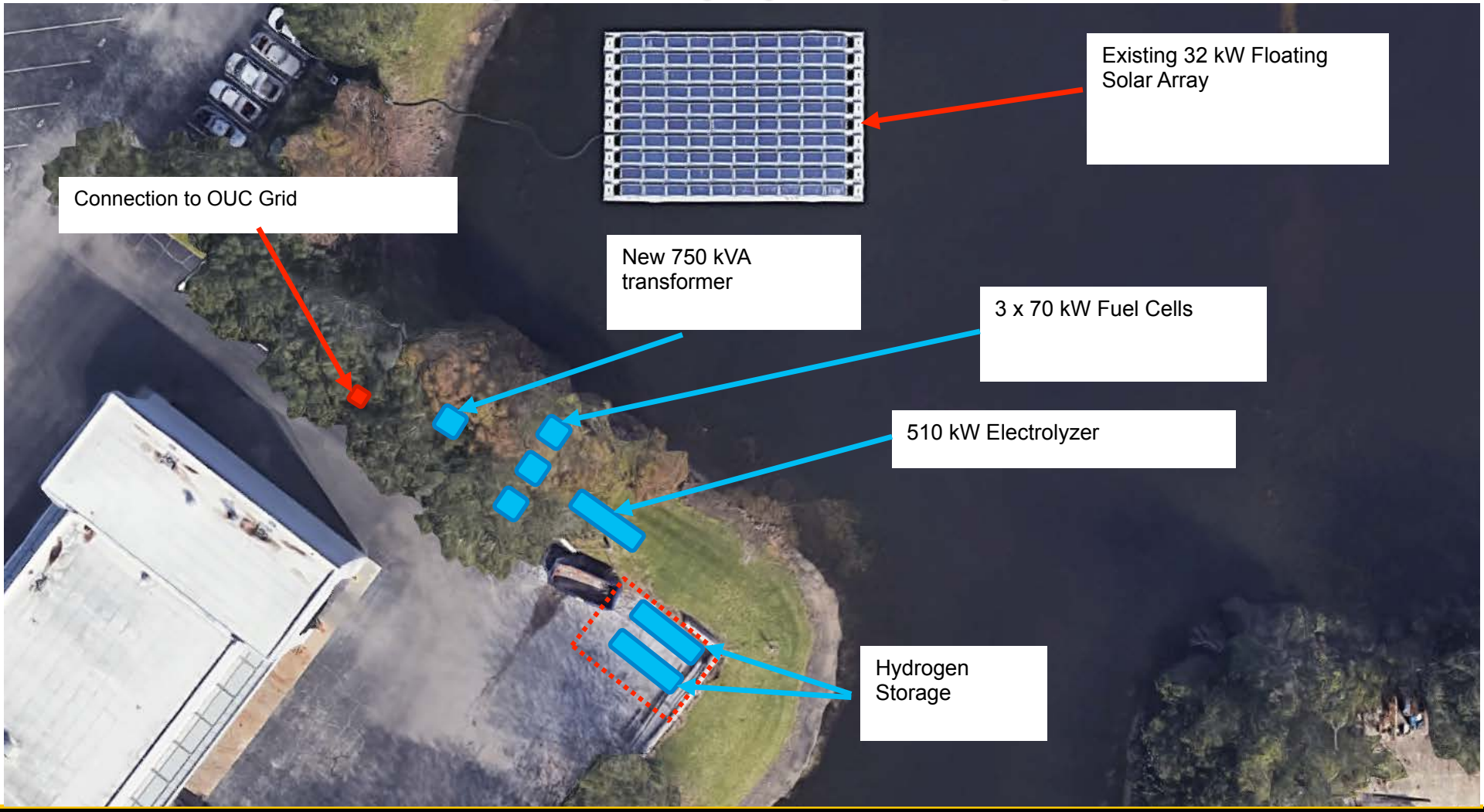
Output variation from an 8.9 MW_{AC} array[3]

4

Sources: [1] CAISO. [2] Florida Public Service Commission. [3] OUC.

Demonstration of Integrated Hydrogen Production and Consumption for Improved Utility Operations

Proposed Equipment Layout



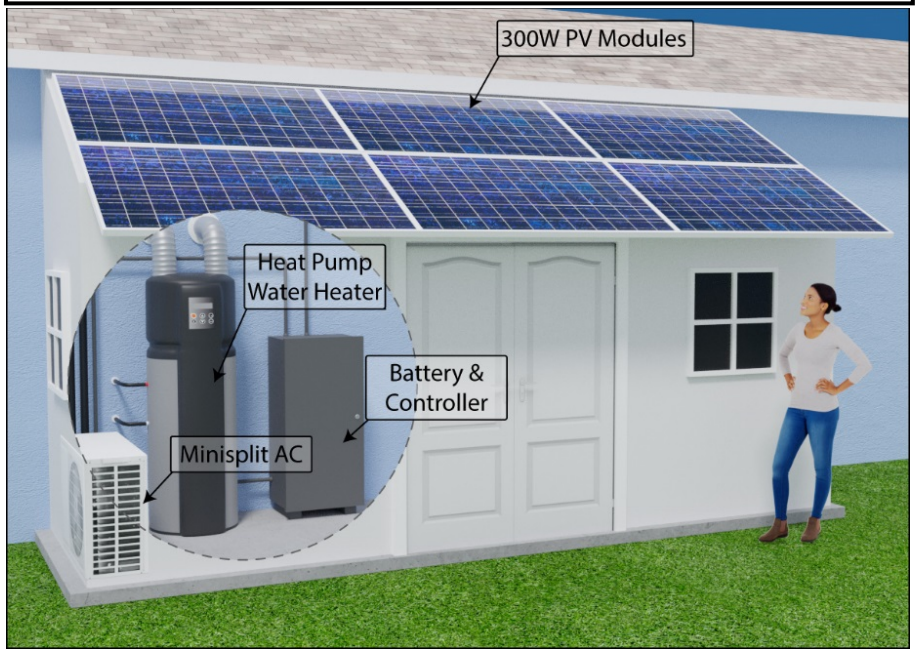
Submitted Contract — Integration Example

PV-GEMS: Photovoltaic-powered, Grid-enhanced Mechanical Solution.

Eric Martin / University of Central Florida

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

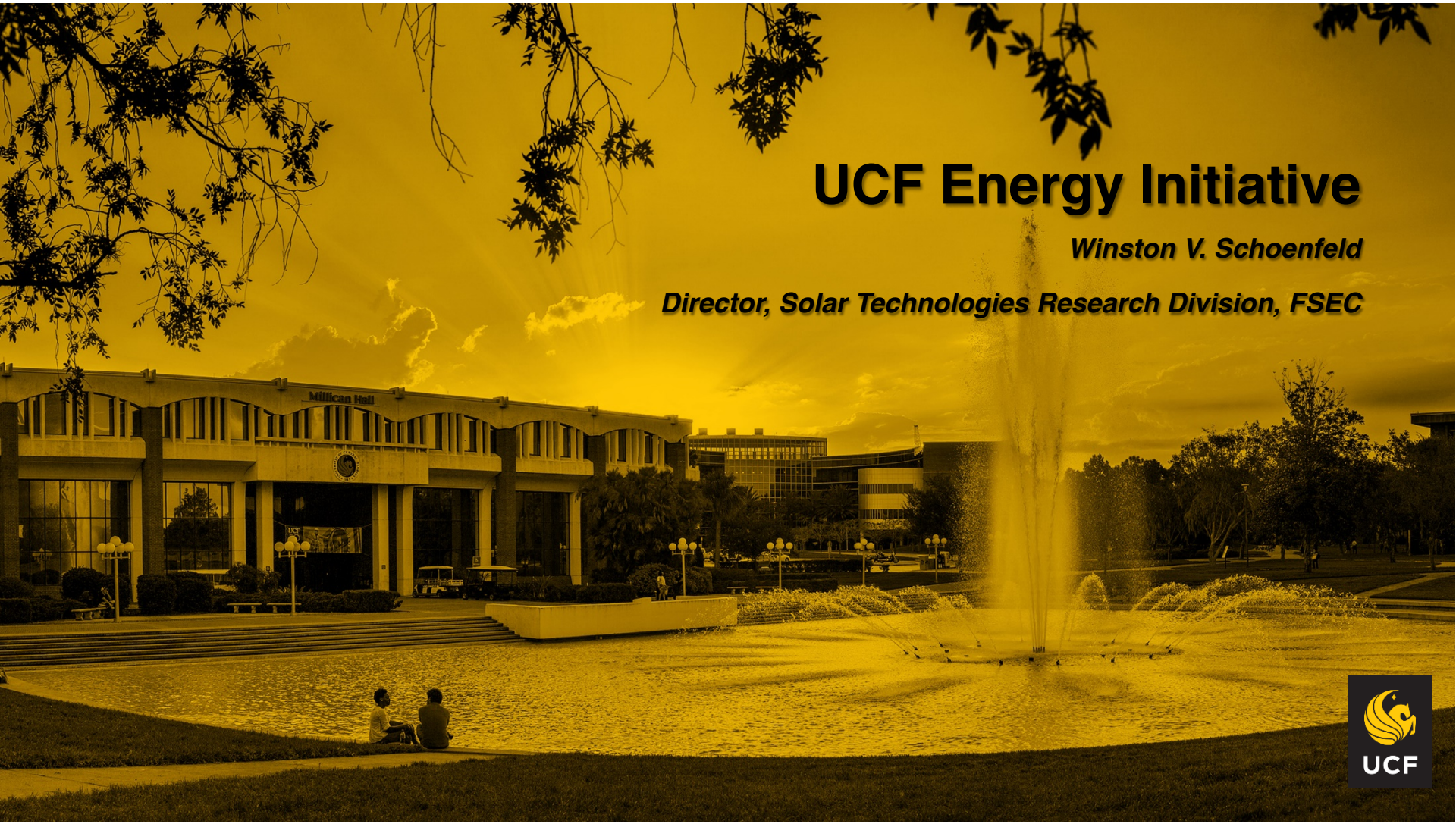
Carlos Colon – FSEC
Jeff Sonne – FSEC
Ankur Maheshwari – Rheem

	Key Milestones & Deliverables
Phase 1	• Proof of concept including achievement of energy savings goals.
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.**

U.S. DEPARTMENT OF ENERGY



UCF Energy Initiative

Winston V. Schoenfeld

Director, Solar Technologies Research Division, FSEC

UCF

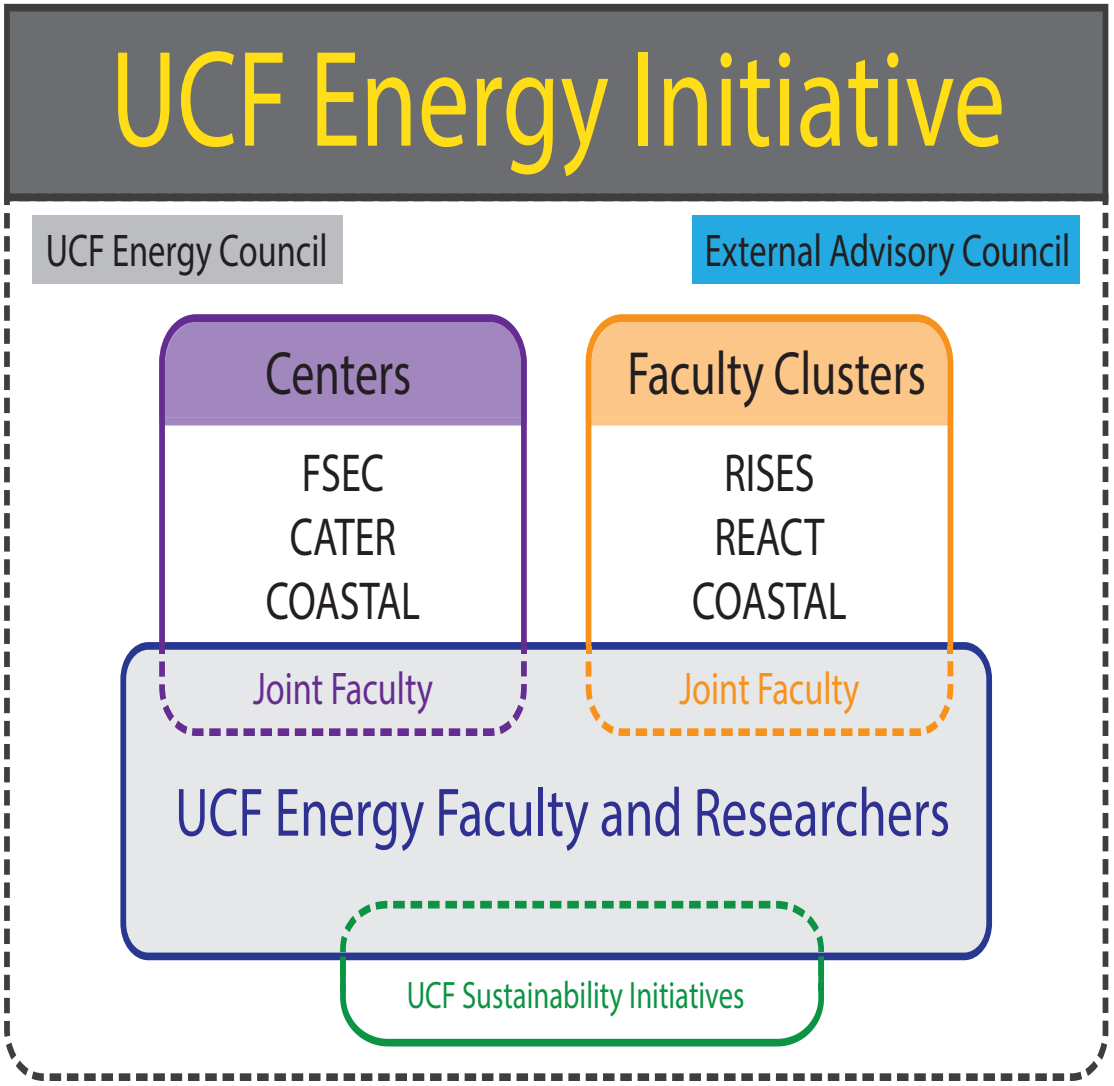
Energy Blue-Ribbon Panel

- 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

Strategic Plan

UCF | FSEC Energy Research Center

UNIVERSITY OF CENTRAL FLORIDA

Strategic Plan (2020-2025)
Executive Summary

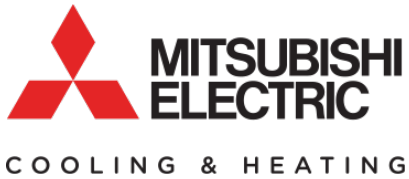
Vision Statement

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 Rebuild Green Energy Services

Brevard Public Schools
THE FUTURE OF FLORIDA'S SPACE COAST

Builders

LifeStyle SINCE 1984 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

ACES Rebuild Green Energy Services

OUC The Reliable One

TECO ENERGY AN EMERA COMPANY

Manufacturers

MITSUBISHI ELECTRIC COOLING & HEATING

RAPID Transforming The Process Industries

Associations/Government

Smart Electric Power Alliance

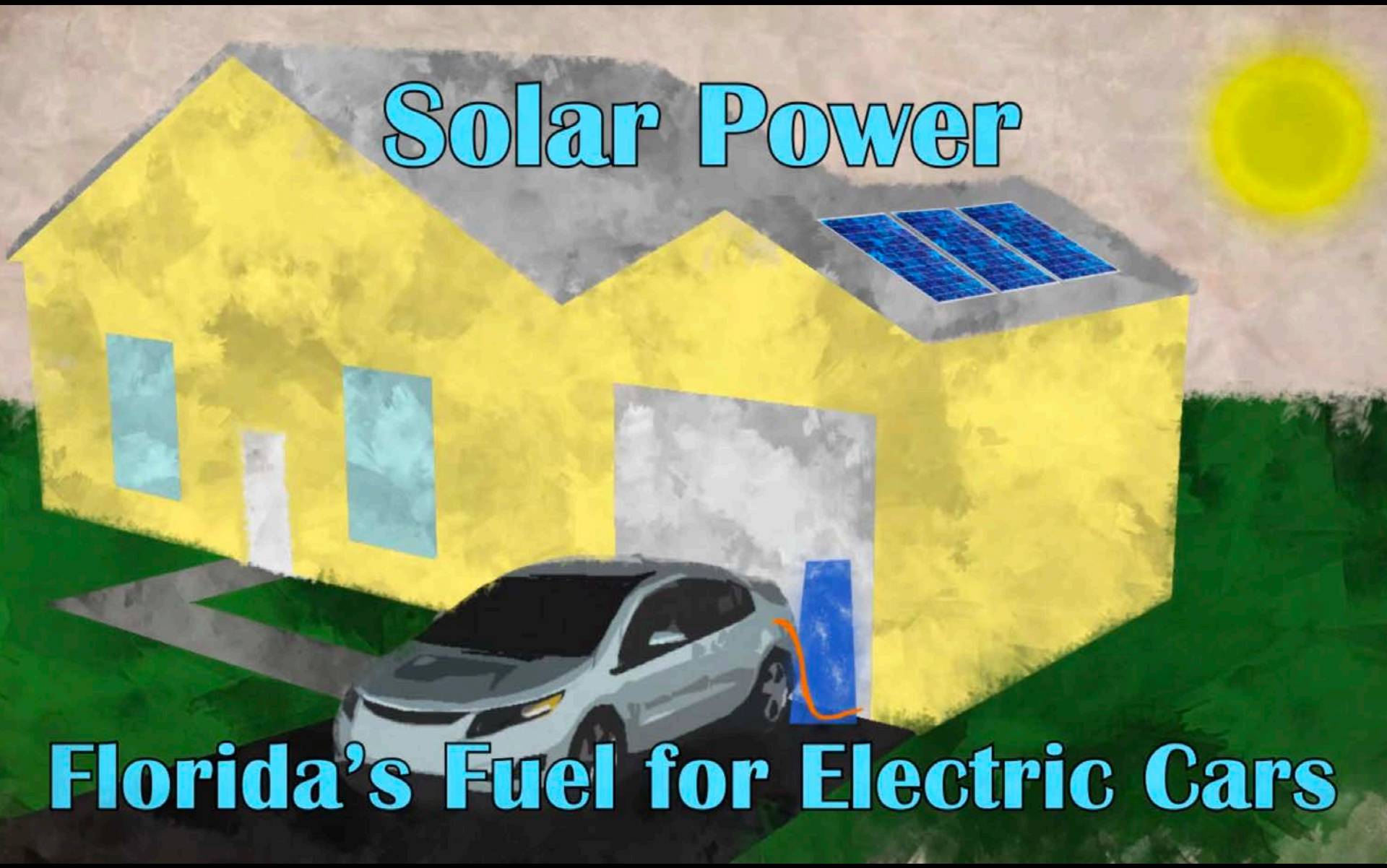
Central Florida Clean Cities Coalition

Drive Electric Florida

Questions?

FSEC Energy Research Center

UNIVERSITY OF CENTRAL FLORIDA



https://vimeo.com/channels/fsec/26289868

SUBMITTED PROPOSALS PENDING

Submitted Proposals PENDING

- Incorporating Residential Energy Efficiency Retrofit Technologies into Integrated Energy and Resilience Planning: A key component to achieving 100% Renewable Energy in Orlando by 2050 - US DOE - $623,253, *E. Martin, D. Parker, K. Fenaughty*
- 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
- Solar Photovoltaic (PV) Systems Training for Electrical Professionals - Directorate of Urban Administration & Development, M.P., Bhopal - $599,796
- 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*