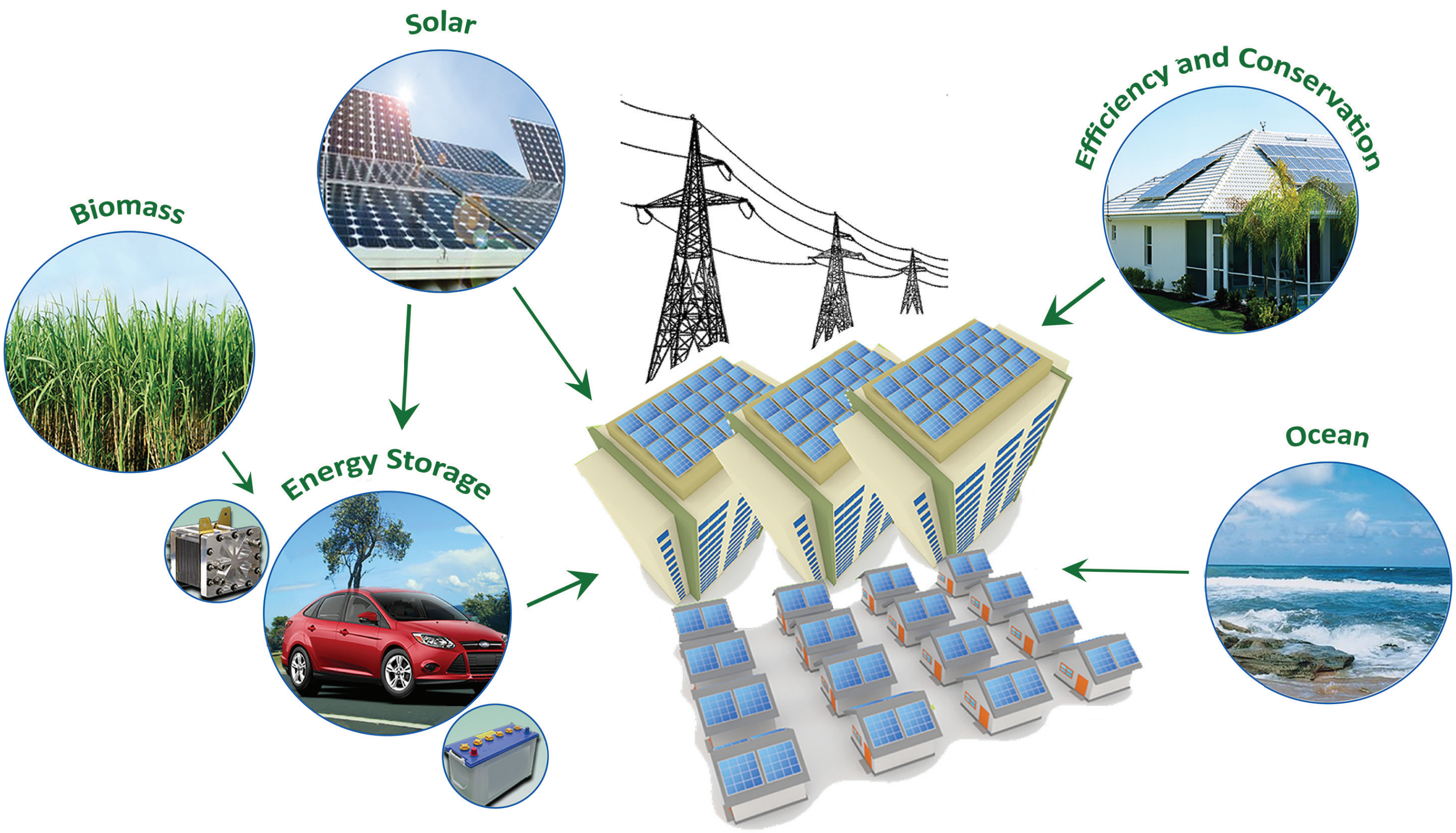
FESC Florida Energy Systems Consortium

2015 Florida Energy Systems Consortium Workshop



May 20-21, 2015

Orlando, Florida

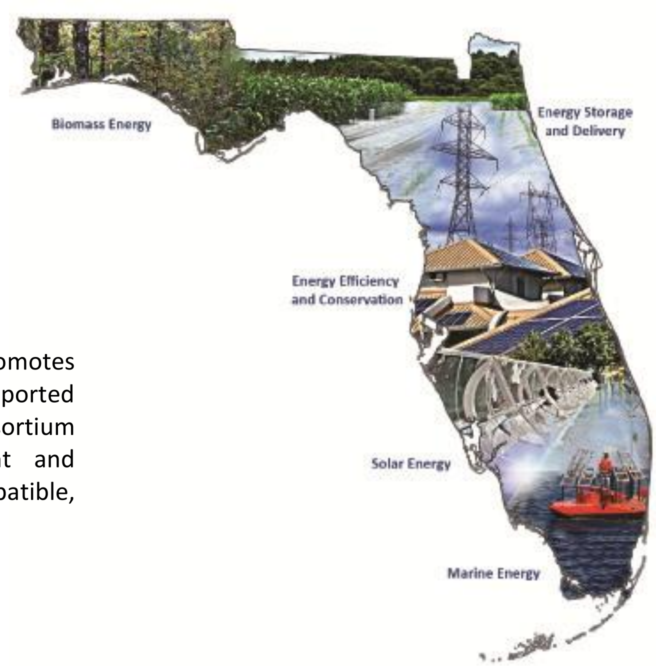
Florida Energy Systems Consortium

TABLE OF CONTENTS

Florida Energy Systems Consortium

FESC BRINGING ENERGY SOLUTIONS TO FLORIDA, THE NATION AND THE WORLD

The Florida Energy Systems Consortium (FESC) promotes collaboration among the energy experts at its 12 supported universities to share energy-related expertise. The consortium assists the State of Florida in the development and implementation of an environmentally compatible, sustainable, and efficient energy strategic plan.



AGENDA

TUESDAY, MAY 19

3:00 - 5:00 pm EARLY CHECK IN/REGISTRATION

WEDNESDAY, MAY 20

7:00 - 8:30 am REGISTRATION, Orlando Airport Marriott Lakeside
POSTER SET-UP for Session I

7:15 - 8:15 am BREAKFAST

GENERAL SESSION: MARRIOTT - GRAND BALLROOM (AMELIA AND SANIBEL)

MODERATOR: JENNIFER CURTIS, FESC DIRECTOR

8:15 – 8:25 am WELCOME

Buck Martinez, Senior Director Office of Clean Energy, Florida Power & Light Company

8:25 – 10:00 am OVERVIEW and POLICY PANEL SESSION

MODERATOR: BUCK MARTINEZ, SENIOR DIRECTOR OFFICE OF CLEAN ENERGY, FLORIDA POWER & LIGHT COMPANY

Overview: ***Florida's Energy Future***
Invited Keynote: Amy L. Stein, Professor, UF Levin College of Law

Policy: ***A Changing Energy Landscape***
Invited Keynote: Jeremy Susac, Berger Singerman

Natural Gas: ***Natural Gas Markets - Why Prices Continue to Trend Lower***
Invited Keynote: Meera Bagati, Sr. Economist, NextEra Energy Resources, LLC

Solar and Smart Grid Key note speakers will join the panel discussion during Q&A

10:00 – 10:15 am BREAK

10:15 – 11:15 am SESSION I: RENEWABLE/ALTERNATIVE POWER AND STORAGE PANEL SESSION MARRIOTT GRAND BALLROOM (AMELIA AND SANIBEL)

MODERATOR: CAMILLE E. COLEY, J.D., ASSISTANT VP FOR RESEARCH, ASSOCIATE DIRECTOR FOR THE SOUTHEAST NATIONAL MARINE RENEWABLE ENERGY CENTER (SNMREC), FLORIDA ATLANTIC UNIVERSITY

Marine Energy: ***Ocean Energy Turbine Development***
Invited Keynote: Phillip Janca, Co-founder, Crowd Energy and Founder, TEKNA Manufacturing, LLC

American Job Project: ***The American Jobs Project: Florida State Roadmap to Clean Energy Jobs***
Invited Keynote: Jin Noh, University of California, Berkeley

11:15 am - 12:25pm SESSION I ORAL PRESENTATIONS (5 min each)

Track I: Renewable/Alternative Power and Storage MARRIOTT – ROOM MARCO

Chair: Camille E. Coley, J.D., Assistant VP for Research, Associate Director for the Southeast National Marine Renewable Energy Center (SNMREC), Florida Atlantic University

- *What's "Current" in Ocean Energy – Camille E. Coley, Florida Atlantic University*
- *Natural Gas: A Pathway to Low Carbon Motor Fuels - David E. Bruderly PE, Bruderly Engineering Associates, Inc.*
- *Selective Non-Catalytic Reduction (SNCR) in a Diesel Engine - John Nuszkowski, David Armstrong, Samantha Delgado, Matt Furlong, Alex Knapp, C. Reid Shore, University of North Florida*
- *Security-Constrained Unit Commitment with Dynamic Ratings – Anna Danandeh, Bo Zeng, Brian Buckley, University of South Florida*
- *General Capacitor's High Energy Li-ion Capacitors - Jim P. Zheng and Wanjun Cao, FAMU-FSU College of Engineering*
- *Optimization of LiMnPO4 Using Solid State Processes – Charles Oladimeji, P.L. Moss, FAMU-FSU College of Engineering*
- *Hydrogen Energy Storage for On-Board Fuel Cells, Concentrated Solar Power and Secondary Batteries – Sesha Srinivasan, Ryan Integlia, Jaspreet Dhau, Jorge Vargas, Florida Polytechnic University*
- *Flywheel Energy Storage for Rural Residential Applications Supplied by Intermittent Wind Power - Ahmed Elsayed, Tarek Youssef, Osama Mohammed, Florida International University*
- *Quest for Grid Energy Storage: Case for the Performance of Iron-Ion/Hydrogen Redox Flow Battery Mixed Electrolytes - Venroy Watson, Derrick Nguyen, Edward E. Effiong, Egwu E. Kalu, Florida A & M University*
- *Economic Performance of Thermal Energy Storage Integrated with Natural Gas Combined Cycle Power Plants - Barry Osterman-Burgess, Yogi Goswami, Elias Stefanakos, University of South Florida/CERC*
- *FAMU Spheromak: Fusion Energy for Distributed Energy Resources - Jerry Clark, Charles A. Weatherford, Ronald Williams - Florida A&M University*
- *Renewable Cities: Technology, Goals, and Implementation - Santiago Arias, Darren Brandes, Christopher Brown, Caroline Mayer, Fazil T. Najafi, University of Florida*
- *A Systems Engineering Model for Harvesting Electricity From Shallow Water Tidal Currents - John Domenech, Tim Eveleigh, George Washington University*

Track II: Education MARRIOTT – ROOM CAPTIVA

Chair: Jennifer Curtis, FESC Director

- *Solar Energy Technologies: Fundamentals and Applications in Buildings - Cheng-Xian Lin, Florida International University*
- *Buildings and Energy: Design and Operation vs. Sustainability: an Energy Engineering Course for Florida-specific Building Design & Operation - Prabir Barooah, Duzgun Agdas, Ravi Srinivasan, University of Florida*
- *Renewable Energy Courses for Master's in Global Sustainability - George Philippidis, University of South Florida/Patel College of Global Sustainability*
- *Renewable Energies and Sustainability Education – Ryan Integlia, Sesha Srinivasan, Gary Albarelli, Brian Birky, Jorge Vergas, Jaspreet Dhau, Ghazi Darkazalli, Florida Polytechnic University*
- *Cultivating Change: Using Social Marketing to Encourage Environmental Behaviors - Laura A. Warner, Kathryn A. Stofer, University of Florida*
- *Educating on Economic Realities of Sustainable Energy – Michelle Phillips, Mark Jamison, PURC*
- *Educational Modules in Support of Sustainable Energy Courses - J.C. Ordonez, Sam Yang, M.B. Chagas, K. Ribeiro, C. Ordonez, T. Solano, J.V.C. Vargas, H. Li, Energy and Sustainability Center*
- *Matching Training to Industry Needs - Nina Stokes, Marilyn Barger, Richard Gilbert, FLATE*
- *The University of Florida Training Reactor: Powering Nuclear Education & Innovation - Shannon L. Eggers, Kelly A. Jordan, University of Florida*
- *Save Money: Be a Savvy Consumer of Energy - Heidi Copeland, Will Sheftall, Bob Seaton, University of Florida/IFAS Extension*
- *Developing Leaders for a Sustainable Future - Linda Seals, Holly Abeels, Gayle Whitworth, University of Florida/IFAS Extension Brevard County*

12:25 - 1:00 pm SESSION I POSTER REVIEW AND DISCUSSIONS

1:00 – 2:30 pm BUFFET LUNCH – INFORMAL ROUND TABLE DISCUSSIONS

REMOVAL OF SESSION I POSTERS and SET-UP of SESSION II POSTERS

2:30 – 3:30 pm SESSION II: BIOMASS AND SOLAR ENERGY PANEL SESSION

MARRIOTT GRAND BALLROOM (AMELIA AND SANIBEL)

MODERATOR: TOMMY BOROUGHS, PARTNER, HOLLAND & KNIGHT

Biomass: ***Transformational Biomanufacturing Technologies for Sustainable Fuel and Chemical Production***
Invited Keynote: Ramon Gonzalez, Professor, Chemical & Biomolecular Engineering, Bioengineering, Director, Energy and Environment Initiative (EEI), Rice University

Solar Energy: ***State of the Solar Market: Innovations and Trends***
Invited Keynote: Miriam Makhyoun, Solar Energy Industry Expert

3:30 – 4:40 pm SESSION II SHORT ORAL PRESENTATIONS (5 min each)

Track I: Biomass MARRIOTT – ROOM MARCO

Chair: George Philippidis, Associate Professor, Sustainable Energy, Patel College of Global Sustainability, University of South Florida

- *Development and Scale-Up of a Horizontal Bioreactor for High-Density Cultivation of Microalgae - Ioannis Dogaris, Michael Welch, Bethany Loya, Andreas Meiser, Lawrence Walmsley, George Philippidis University of South Florida*
- *Cultivation and Optimization of Saline Microalgae BG0011 for Production of Biofuels and Bioproducts - Yingxiu Zhang, Tung Chen, Vincent Ferrone, Cesar M Moreira, Spyros Svoronos, Edward Phlips, Pratap Pullammanappallil, University of Florida*
- *Introducing a Membrane Photobioreactor for Cultivating Microalgal Biofuels in Wastewater - Ivy Drexler, M Pickett, DH Yeh, University of South Florida*
- *Industrial Sweetpotato and Energybeet Potential for Biofuel Feedstocks in South Florida - Brian Boman, Edward Evans, Ann Wilkie, Janie Ryan-Bohac, University of Florida/Indian River REC*
- *Evaluating the Bioenergy Potential of Sweetpotato Vines - Wendy A. Mussoline, Ann C. Wilkie, University of Florida/IFAS Extension*
- *Florida Farm to Fly: Advanced Biofuel Feedstock Supply Chain Integration - Ben DeVries, Treasure Coast Research Park*
- *Reinvigorating Oleoresin Collection in the Southeastern USA: Evaluation of Stand Management and Tree Characteristics with Borehole Tapping - J. Lauture, Gary Peter, A. Hodges, University of Florida*
- *An Intensified Process for Production of Liquid Hydrocarbon Fuels From Biogas to Overcome BGTL Economy of Scale Challenges - Nada Elsayed, Babu Jospeh, John Kuhn, University of South Florida*
- *Adaptation of Mesophilic and Thermophilic Anaerobic Digester to Saline Conditions - Doan, Nguyet, Cabrol, L., Moreira, C., Tapia, E., Svoronos, S. A., Phlips, E., Ruiz-Filippi, G., Pullammanappallil, P.C., University of Florida*
- *Novel Biocatalylic Process for Biodiesel Production - Huali Wang, Brent Chrabas, Viesel Fuel LLC.*

Track II: Solar Energy MARRIOTT – ROOM CAPTIVA

Chair: Jim Fenton, Director, Florida Solar Energy Center

- *An Analysis Between the State of Solar Energy Development in Europe and the United States - Mary Kate Fitzgerald, Gage Vincent, Estelle Wilson, Pan Xu, Nicholas Yonezawa, Fazil T. Najafi, University of Florida*
- *Advancing Solar – Susan Glickman, Southern Alliance for Clean Energy*
- *The Integration of Solar Power as a Renewable Source of Energy in the United States - Patricia Cruz, Doug Hinton, Dorian Johnson, Cara Keller, Giuseppe Zuozo, Fazil T. Najafi, University of Florida*
- *Conducting Polymer-Dye Composites for Photoelectrochemical Solar Cells and Energy Storage - Arash Takshi, University of South Florida*
- *Atmospheric Pressure Chemical Vapor Deposition of Functional Oxide Materials for Crystalline Silicon Solar Cells - Kristopher O. Davis, Winston V. Schoenfeld, University of Central Florida/FSEC*
- *Establishing Field Equivalents of Accelerated Tests for Bypass Diodes in PV Modules – Narendra Shiradkar, Vivek Gade, Kalpathy Sundaram, Winston Schoenfeld, University of Central Florida*
- *Factors in the Formation of Cracks in Mono-Crystalline Silicon Solar Cells - Hubert Seigneur, Narendra Shiradkar, University of Central Florida*
- *Nanoscale Interfaces in Energy Application - Luping Li, Cheng Xu, Kirk J. Ziegler, University of Florida*
- *Recent Advances in Polymer Solar Cells - Ifedayo Ogundana, Simon Y. Foo, Zhibin Yu, Indranil Bhattacharya, Florida State University*
- *Smart Solar Electric Vehicle Technology - Ashly Locke, Ryan Integlia, Sesha Srinivasan, Jorge Vergas, Jaspreet Dhau, James Mulharan, Eric Vickers, Florida Polytechnic University*
- *Performance Analysis of C-Si Module Deployed at FSEC After 10 Years Exposure - Eric Schneller, Joe Walters, Stephen Barkaszi, Kris Davis, Winston Schoenfeld, University of Central Florida*
- *Solar Thermochemical Fuel Production at the University of Florida - Jonathan R. Scheffe, David W. Hahn, Renwei Mei, University of Florida*
- *High Efficiency Thermochemical Fuel Production Using the UF 10 kW Solar Reactor - Kelvin Randhir, Like Li, Nick AuYeung, Amey Barde, Benjamin Greek, Nathan Rhodes, Renwei Mei, David Hahn, James Klausner, University of Florida*
- *The Costs and Benefits of Solar Road Technology - Courtnay Cardozo, Juan Camargo, Kyle Findlater, Josh Herrera, Fazil T. Najafi, University of Florida*

4:40 – 5:20 pm BREAK and SESSION II POSTER REVIEW AND DISCUSSIONS

5:20 pm *REMOVAL of SESSION II POSTERS and SET-UP of ADDITIONAL POSTERS*

5:25 – 5:55 pm ADDITIONAL POSTER SESSION

Renewable/Alternative Power and Storage (Poster Session)

- *Sustainability in Rapid Prototyping - Joseph Prine, John McCormack, Jorge Vargas, Jaspreet Dhau, Sesha Srinivasan, Ryan Integlia, Florida Polytechnic University*

Biomass (Poster Session)

- *Dual Purpose Benefits of the Sweetpotato Crop: Biofuel and Animal Feed - Lara R. Nesralla, Wendy A. Mussoline, Ann C. Wilkie, University of Florida/IFAS*
- *Cultivation of Filamentous Algae for Bioenergy Production - Kimberly D. Hafner, Ann C. Wilkie, University of Florida*
- *Impact of Phytohormones on Microalgal Growth and Lipid Content - Brett S. Nelson, Ann C. Wilkie, University of Florida*
- *Techno-Economic Analysis of Bioethanol Production from Lignocellulosic Biomass: Process Integration with Energy Recovery from Wastes - Na Wu, Spyros Svoronos, Lonnie Ingram, Ismael Nieves, Pratap Pullammanappallil*
- *Synthesis of Biodiesel via Supercritical Transesterification Route from Waste Cooking Oil - Z. Cerniga, Shriyash Deshpande, D. Townsend, K. Cogswell; A. Driscoll, A. Sunol, G. Philippidis, M. Pandey, University of South Florida*

Solar Energy (Poster Session)

- *Avian Mortality at Solar Energy Facilities in Southern California - Stephanie Meyers, Lee Walston, University of Illinois at Urbana–Champaign*
- *A Thermo-Mechanical Method for Fabrication of Porous Structure for Solar Thermo-Chemical Fuel Production - Kelvin Randhir, Like Li, Nick AuYeung, Amey Barde, Renwei Mei, David Hahn, James Klausner, University of Florida*
- *Detailed Analysis of Spatially Mapping Solar Cell Parameters - Kortan Ogutman, Kris Davis, University of Central Florida*
- *Modeling of Scroll Expanders for Decentralized Power Generation using Solar Energy as Heat Source - Arun Kumar Narasimhan, Rajeev Kamal, Yogi Goswami, Elias K. Stefanakos, University of South Florida*
- *Investigation of Long Term Reactive Stability of Ceria for Use in Solar Thermochemical Cycles - Nathan R. Rhodes, Michael M. Bobek, David W. Hahn, University of Florida*

- *High Throughput Processes for PV Module Manufacturing - Vasilios Palekis, S. Collins, V. Evani, M. Khan, C. S. Ferekides, University of South Florida*
- *Understanding the Impact of Point Defects on the Performance of Thin Film Solar Cells – Vamsi Evani, M. I. Khan, P. Bane, V. Palekis, S. Collins, C. Ferekides, University of South Florida*

Energy Efficiency (Poster Session)

- *Anomaly Identification, Detection and Correction on Distribution Networks: a Non-technical Power Loss Study Case - Rodrigo D. Trevizan, Aquiles Rossoni, Arturo S. Bretas, University of Florida*
- *Integration of Technologies for Recovery of Energy and Nutrients from Dairy Wastes – Shunchang Yang, University of Florida*
- *An Experimental Investigation of Occupancy-Based Control of Commercial Building Climate - Jonathan Brooks, Siddharth Goyal, Rahul Subramany, Yashen Lin, Timothy Middelkoop, Prabir Barooah, University of Florida*

Smart Grid & Energy Storage (Poster Session)

- *Distributed Optimization-based Load Control in a Power Grid for Primary Frequency Response while Minimizing Consumer Disutility - Jonathan Brooks, Prabir Barooah, University of Florida*
- *Smart And Flexible Resources to Harness Solar Power in Florida - D. Surya Chandan, A. S. Bretas, Sean Meyn, Prabir Barooah, University of Florida*
- *Solar-Driven Photo-Thermochemical Water-Splitting Cycle with Integrated Thermal Energy Storage - Nazim Muradov, Ali T-Raissi, Nan Qin, University of Central Florida/FSEC*

5:55 pm *REMOVAL OF ADDITIONAL POSTERS*

6:00 – 7:15 pm RECEPTION – CAPRI GREAT LAWN

7:00 pm DINNER ON YOUR OWN

FESC Florida Energy Systems Consortium

THURSDAY, MAY 21

7:00 - 8:30 am REGISTRATION, Orlando Airport Marriott Lakeside
POSTER SET-UP for Session III

7:30 - 8:30 am BREAKFAST

8:30 – 9:00 am GENERAL SESSION: MARRIOT GRAND BALLROOM (AMELIA AND SANIBEL)
MODERATOR: JENNIFER CURTIS, FESC DIRECTOR

Invited Keynote: ***A Grid in Transition - A look at Power Systems Regulations***
Jordan Kislear, Program Analyst at US Department of Energy

9:00 – 10:00 am SESSION III: ENERGY EFFICIENCY AND SMART GRID/ENERGY STORAGE PANEL SESSION
MARRIOT GRAND BALLROOM (AMELIA AND SANIBEL)
MODERATOR: JEREMY SUSAC, BERGER SINGERMAN

Energy Efficiency: ***Some History, Buildings and the Grid***
Invited Keynote: Jim Payne, Technology Project Officer, Office of Energy Efficiency and Renewable Energy, US DOE

Smart Grid: ***Bridging Gaps between Design, Operations and Software in Smart Grids—Next Generation SCADA***
Invited Keynote: Marija Ilic, Professor of Electrical & Computer Engineering and Engineering & Public Policy, Carnegie Mellon University

10:00 – 10:15 am BREAK

10:15 – 11:25 am SESSION III ORAL PRESENTATIONS (5 min each)

Track I: Energy Efficiency MARRIOTT – ROOM MARCO
Chair: Rob Vieira, Director, Buildings Research Division, Florida Solar Energy Center

- *Boosting Efficiency in Buildings - Chris Castro, Jonathan Ippel, City of Orlando*
- *High Efficiency Multi-Family Housing Renovations at UF's Corry Village - Craig Miller, Bahar Armaghani, Steve Wargo, University of Florida Program for Resource Efficient Communities*
- *Efficiency of Florida's Affordable Multifamily Housing: Diving Deeper into Consumption, Property, and Tenant Characteristics Data - Nicholas Taylor, Anne Ray, Jennison Searcy, Lesly Jerome, University of Florida Program for Resource Efficient Communities*
- *Multifamily Energy-Efficiency Retrofit Programs: A Florida Case Study - Nicholas Taylor, Jennison Searcy, Pierce Jones, University of Florida*
- *Design of Incentive Programs to Promote Net Zero Energy Buildings - Alireza Ghalebani, Tapas K Das, University of South Florida*

- *Experimental Exergy Analysis of an Off-Grid Zero Emissions Building - Sam Yang, M. Chagas, J.C. Ordonez, J.V.C. Vargas, C. Ordonez, Florida State University*
- *Optimization of Chilled Water Plant Operation using Modelica Buildings Library - Sen Huang, Wangda Zuo, University of Miami*
- *Transportation Energy and Space Technology Hub (TEST Hub) at NASA Kennedy Space Center - Advanced Transit Technology Demonstration Projects: Dual-Fuel Fuel Cell Demonstration and Thermo Electric Generation Transit Bus Demonstration - David Teek, Tim Franta, Mike Aller, Energy Florida*
- *Ducted Heat Pump Water Heater Cooling and Heating Performance in Florida - Carlos Colon, Eric Martin, Danny Parker, University of Central Florida/ FSEC*
- *Greenstar Roof Insulation: Heat Evicting Innovation – Paul White, Greenstar Panels*
- *Planning for Urban Sustainability: Comparing the Impacts of Residential Design Alternatives - Lynn M. Jarrett, Hal S. Knowles III, Barbra C. Larson, University of Florida/Program for Resource Efficient Communities*
- *Performance and Energy Efficiency Analysis of Join Algorithms on GPUs - Ran Rui, Hao Li, Yicheng Tu, University of South Florida*
- *Smart Meter Data Analytics – Using Data for Energy Efficiency, Kevin Burns, Orlando Utilities Commission*
- *Dynamic Power-Aware Disk Storage Management in Database Servers - Peyman Behzadnia, Yicheng Tu, University of South Florida*
- *Dynamically Controlled Smart Walls – The New Standard for Home and Building Construction - Justin Zhou, Julius Regalado, IVy Composites, Inc. (Poster Only)*

Track II: Smart Grid & Energy Storage MARRIOTT – ROOM CAPTIVA

Chair: Sean Meyn, Director Florida Institute for Sustainable Energy, Director Laboratory for Cognition & Control, Professor of ECE and Robert C. Pittman Eminent Scholar Chair

- *Dispatchable Micro-CHP and Micro-CCHP - Stephen Welty, Calor Technologies*
- *A New Way Forward for Energy Companies: Cloud and Mobile Technologies - Ben Amaba, Ph.D., Professional Engineer, CPIM®, LEED® AP BD+C, IBM*
- *eNOS - An Open Source Energy OS - Raymond Kaiser, Amzur Technologies*
- *High Impedance Fault Detection on Distribution Networks: an Adaptive Approach Considering a Noisy Environment - Arturo Bretas, Leonardo Lurinic, Renato Ferraz, University of Florida*
- *Smart Fridge / Dumb Grid : Architecture for the Electricity Network of 2020 - Y. Chen, J. Ehren, R. Kaddah, J. Mathias, P. Barooah, A. Busic, Sean Meyn, University of Florida*
- *Develop Smart Power Inverters to Improve the Performance of Smart Power Grid - Shuo Wang, University of Florida*
- *Home Is Where the Heart Is: Complexity, Pattern, and Meaning in Short Interval Residential Electric Smart Meter Data – Hal Knowles, University of Florida/PREC*
- *Fault Location Identification in Smart Distribution Networks with Distributed Generation - Jose Cordova, Omar Faruque, Florida State University*

- *Real-Time Digital Simulation Based SCADA Lab and HIL Machine Drive Lab at USF - Hossein Ghassempour Aghamolk, Zhixin Miao, Lingling Fan, University of South Florida*
- *Nickel Iron Batteries for Twenty First Century Energy Storage - David Atherton, Randy Ogg, Encell Technologies*
- *G4 Synergetics High Power Battery - Mark Kohler, G4 Synergetics, Inc.*
- *The Impact of Double-use Storage on a Grid Connected House with Photovoltaics - Richard Aarons, Omonayo Bolufawi, Mark H. Weatherspoon, Florida A & M University*
- *Analysis of Coupling Dynamics for Power Systems with Iterative Discrete Decision Making Architectures - Zhixin Miao, University of South Florida*
- *Modeling of Packed Bed Thermal Energy Storage with Encapsulated Phase Change Material - Francesca Moloney, University of South Florida*

11:25 – 11:55 am SESSION III POSTER REVIEW AND DISCUSSIONS

11:55 am *REMOVAL OF POSTERS*

GENERAL SESSION: MARRIOT GRAND BALLROOM (AMELIA AND SANIBEL)

12:00 – 12:05 pm CLOSING REMARKS

Jennifer Curtis, FESC Director

12:05 - 1:15 pm BUFFET LUNCH

1:15 – 4:15pm SHORT COURSE: LARGE-SCALE PROPOSAL DEVELOPMENT AND ACCELERATORS FOR UNIVERSITIES - MARRIOT GRAND BALLROOM (AMELIA AND SANIBEL)

Ben Rowland and Alison Lipson (not pictured)
Founders of University Proposals (universityproposals.com)

Based in the Washington, DC metro area, Ben and Alison have produced more than 1,000 proposals and oral presentations throughout their careers. They are experts at managing every aspect of a proposal and site visit from development through delivery – including technical and research volumes, pre- and full-proposals, facilitating team writing, peer reviews, orals coaching, site visits, and reverse site visits. They assist Principal Investigators and their teams by providing creative solutions, industry knowledge, guidance, and extensive experience in interpreting RFP and FOA solicitation language and requirements.

Short Course Abstract:

Over the years, the proposal industry has developed approaches and processes that accelerate the proposal cycle to organize and streamline preparation, improve the overall quality of the response, and respond specifically and clearly to the requirements. Accelerators directly translate into time and cost savings, stronger proposals, and more wins. Nowhere are these benefits needed more than at universities where time and resources are limited and Government solicitations can be difficult to follow.

During this course, university participants learn valuable skills from the experts that manage large-scale proposals to Federal agencies such as the DOE, NSF, and NASA. Participants will learn new approaches to old problems that all universities struggle with. They receive powerful reference material (including virtual resources) they can use on their next proposal and every one after that. The seminar includes a question and answer period and participants are encouraged to stay and discuss their toughest problems.

Accelerators 101 – Organizing and Outlining (approximately 60 minutes)

- Organizing Your Response to Meet the Requirements
- Outlining to "Answer The Mail": Developing Your Proposal From the Solicitation
- Converting Requirements Into Your Words
- Author Guidance: What Authors Should Know and Do
- From the Start – Leverage Your Strengths and Mitigate Your Weaknesses

- Harmonizing One-Voice

3:00 – 3:15pm BREAK

Accelerators 102 – Proposal Process and Parts (approximately 60 minutes)

- Role of Proposal Team Members (even if there's only one of you)
- Meaningful Internal and External Reviews
- Look Good and Read Well: Formatting and Editing
- Summaries That Sizzle
- Resumes and Bios That Rock
- Graphics Accelerators

Questions & Answers (approximately 30 minutes)

INVITED KEYNOTE SPEAKERS

Meera Bagati, Senior Economist, NextEra

Meera Bagati is a Senior Economist with NextEra Energy Resources. At NextEra, she focuses on fundamental research on all major commodity markets including natural gas, natural gas liquids, oil and related markets. Meera has been active in the energy markets for 15 years. Previously, she was with Dominion Resources, one of the nation's largest producers and transporters of energy, where she was a Project Manager in their Business Planning & Market Analysis group. At Dominion, she led the firm’s in-depth fundamental-based natural gas market analysis, focused on both short-term and long-term market outlooks. Prior to Dominion, Meera was an Upstream Analyst for PFC Energy (now part of IHS), a global energy research and consultancy group focused on regional and global oil and gas exploration and production strategy, analysis, and development. There, she worked with leading North American oil and gas producers on corporate strategy, competitor analysis, and competitive benchmarking. Meera has a Bachelor’s in Economics from Delhi University, Delhi, India, and a M.S in International Economics from Radford University, Virginia.

Dr. Ramon Gonzalez, Professor, Chemical & Biomolecular Engineering and Bioengineering; Director, Energy and Environment Initiative; Rice University, Houston TX; Program Director, Advanced Research Projects Agency—Energy (ARPA-E), U.S. Department of Energy, Washington D.C.

Dr. Ramon Gonzalez is a Professor in the Departments of Chemical & Biomolecular Engineering and Bioengineering at Rice University where he leads the Metabolic Engineering and Synthetic & Systems Biology laboratory with the goal of engineering biological platforms for the sustainable production of fuels and chemicals. He is also the Director of Rice’s Energy and Environment Initiative (EEI) where he leads faculty and programmatic development of university-wide energy and environment research to develop transformational and sustainable energy technologies.

Dr. Gonzalez has published over 60 articles in leading scientific journals, is the lead inventor in ten patents or patent applications, and has given over 80 invited talks. He holds several editorial positions including Senior Editor of the Journal of Industrial Microbiology & Biotechnology and Member of the Editorial Board of Science, Applied & Environmental Microbiology, Biotechnology Journal, Metabolic Engineering Communications, Applied Biochemistry & Biotechnology, and Food Biotechnology. Dr. Gonzalez was the Program Chair of the 2011 Annual Meeting of the Society for Industrial Microbiology and Biotechnology (SIMB), and currently serves as a Director in the SIMB's Board of Directors. He is co-founder of Glycos Biotechnologies, Inc., a Houston-based technology company.

Dr. Gonzalez is also a Program Director at the Advanced Research Projects Agency-Energy (ARPA-E) of the U.S. Department of Energy. His areas of technical focus include biological conversion of natural gas and other sources of methane to liquid fuels and the direct synthesis of liquid fuels from carbon dioxide. Dr. Gonzalez received a Ph.D. in Chemical Engineering from the University of Chile, a M.S. in Biochemical Engineering from the Pontifical Catholic University of Valparaíso (Chile), and a B.S. in Chemical Engineering from the Central University of Las Villas (Cuba).

Dr. Marija D. Ilic, Professor of Electrical and Computer Engineering at Carnegie Mellon University

Marija D. Ilic received her Doctor of Science Degree in Systems Science at Washington University in St. Louis, MO in 1980. She is currently a Professor of Electrical and Computer Engineering and Engineering at Carnegie Mellon University, Pittsburgh, PA, with a courtesy appointment in the Public Policy Department. She is the Director of the Electric Energy Systems Group (EESG) at Carnegie Mellon. She was an Assistant Professor at Cornell University, Ithaca, NY, and tenured Associate Professor at the University of Illinois at Urbana-Champaign. She was then a Senior Research Scientist in Department of Electrical Engineering and Computer Science, Massachusetts Institute of Technology, Cambridge, from 1987 to 2002. She has over 30 years of experience in teaching and research in the area of electrical power system modeling and control. Her main interest is in the systems aspects of operations, planning, and economics of the electric power industry. She has co-authored and co-edited a number of books in her field of interest. Her most recent book is Engineering IT-Enabled Sustainable Electricity Services: The Tale of Two Low-Cost Green Azores Islands. Prof. Ilic is an IEEE Fellow.

Phillip P. Janca, Co-founder, Crowd Energy, and Founder, TEKNA Manufacturing, LLC

- 1974 conducted the first successful stateside repair of a critical level Nuclear Reactor using the cooling water as a radiation shield.
- 1975 North Sea Saturation Diver 760 to 985 fsw.
- 1976 Deep Diving Manned Submersible Pilot.
- 1976-1998 Diving Research Officer at the University of the West Indies (UWI) Associate Researcher UWI until 1998.
- 1976 Built, installed and operated the National Recompression Chamber in Jamaica
- 1980 founded Research Submersibles Ltd., a Grand Cayman based company, which eventually became the largest operator of deep diving manned submersibles in the world.
- 1984 using the deep diving submersible Pisces II located the battleship YAMATO in 1,781 fsw off the coast of Japan and filmed it for NHK Public Television special on the 40th anniversary of it's sinking by the U. S. Navy.
- 1986 discovered a new species of reef building sponges ***thrombus jancai***
- 1998 founded TEKNA Manufacturing, LLC , which continues to design and build code compliant HBOT systems for distribution worldwide.

Jordan Kislear, Program Analyst at US Department of Energy

Jordan Kislear has worked with the Office of Clean Coal and Carbon Management within the Office of Fossil Energy at the US Department of Energy. He is responsible for outreach and engagement between his office and other federal agencies, such as the Environmental Protection Agency, and conducts outreach activities regarding carbon capture, utilization, and storage (CCS) and clean coal technology developments.

Previously, Mr. Kislear has conducted research at the National Energy Technology Laboratory, and has been detailed to the Office of Management and Budget. He has also supported the Energy Information Administration on environmental controls work.

Mr. Kislear's primary experience is in regulatory matters affecting fossil based power generation, as well as experience in techno-economic and systems analyses of advanced power generation technologies. He earned a B.S. from the Pennsylvania State University in Mechanical Engineering, and a M.S. in Systems Engineering from Johns Hopkins University. He also holds a Lean Six Sigma Black Belt certification.

Miriam Makhyoun, Solar Energy Industry Expert

Miriam Makhyoun was Research Manager at Solar Electric Power Association (SEPA) from 2013-2015 where she conducted market, regulatory and technology analyses, managed collaborative projects, and wrote publications, leveraging her background in both business and technology. In June of 2015, Miriam will start a new position at Pacific Gas & Electric in California. Her specialties include grid energy storage, value of solar tariff design, solar energy forecasting, advanced inverter functionality, and market analysis. Miriam began her career in market intelligence at North Carolina Sustainable Energy Association. She holds a Master of Science in Technology with a concentration in Appropriate Technology and a Master of Business Administration with a concentration in Sustainable Business from Appalachian State University.

Buck Martinez, Senior Director, Office of Clean Energy, Florida Power and Light Company

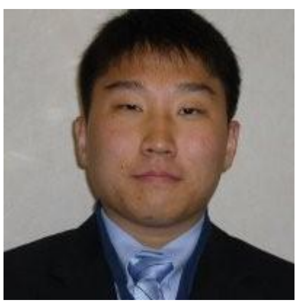
J.L. Martinez oversees the Office of Clean Energy at FPL, a subsidiary of NextEra Energy, where his responsibilities include identifying and originating clean energy opportunities in the state to promote visibility, commitment, and economic development. Most recently, Mr. Martinez led the Company's efforts in the development of three large solar projects and three large combined cycle natural gas facilities. NextEra Energy is one of the nation's leading electricity-related services companies. Its subsidiaries include Florida Power & Light Company, Florida's largest electric utility with nearly 4.6 million customer accounts, and NextEra Energy Resources, a fast-growing independent power producer with a presence in 26 states.

Mr. Martinez joined Florida Power & Light in 1981. Prior to being named to his present position, he served as Senior Director of Project Development in the state. Before that he served as Director of Human Resource Services overseeing the corporate safety department, labor relations, and the corporate quality program. He has also served the company in various management positions and special projects.

Mr. Martinez holds a Bachelor of Arts degree from St. Thomas University and a Master of Business Administration degree from Nova Southeast. In addition, he is a graduate of the Boston University Leadership Program., and the Harvard Program on Negotiation. Most recently, Mr. Martinez was elected to the St. Thomas University Hall of Fame. Mr. Martinez serves as the Chairman of the Florida Solar Energy Center and also serves on other Advisory Boards throughout the State, most notably The Florida Energy Systems Consortium, The Florida Research Consortium (FRC), and The St. Thomas University President's Advisory Board. He has also worked closely with the Department of Energy on renewable energy initiatives and is active in speaking engagements throughout the country. Mr. Martinez is also on the West Palm Board of the Fellowship of Christian Athletes and recently founded Student Aces (ACE), a not for profit organization dedicated to the development of leadership for high school students.

He and his wife Silvia, their three children and four grandchildren, live in Palm Beach Gardens, Florida.

Jin Noh, Goldman School of Public Policy, University of California, Berkley



Jin Noh is a second-year Master's in Public Policy student with a focus in energy markets, innovation, and finance at the Goldman School of Public Policy at the University of California, Berkeley. For his graduate thesis project, Jin has conducted econometric analysis with the Department of Energy in evaluating the effect of storm-related outage events on grid resilience investment decisions. As a graduate student, he has also consulted Sonoma Clean Power on strategies to implement behavior-based energy efficiency programs and to design cost-effective energy storage procurement incentives. Prior to coming to Goldman, Jin worked for four years at SRI International where he consulted national research agencies, laboratories, and universities on science, technology, and innovation policy issues. He has a B.A. in Public Policy and Economics from Duke University.

Jim Payne, Technology Project Officer, Office of Energy Efficiency and Renewable Energy, US DOE

Jim Payne is a Technology Project Officer within Building Technologies Office's (BTO's) Emerging Technologies Program. In this position he manages projects that are awarded through the competitive funding process, and is involved with the development of DOE funding opportunities. He has a BSEE from Virginia Tech, and is a certified PMP. Prior to joining BTO, he was on a team that managed a portfolio of awards that covered multiple technologies within EERE. Jim began with DOE in early 2008 in the Solar Energy Technologies Office. Prior to joining DOE, Jim was with NASA's Goddard Space Flight Center for 23 years. While in the Laboratory for Astronomy and Solar Physics he supported NASA scientists designing and fabricating instrumentation for spacecraft. He is also former U.S. Navy.

Ben Rowland and Alison Lipson (not pictured), University Proposals, LLC

For nearly two decades, Ben Rowland and Alison Lipson have specialized in the development and management of Federal, state, and local proposals and oral presentations. They have consulted with dozens of Fortune 500 companies, international organizations, universities, and government agencies. In 2010, Ben and Alison formed University Proposals (universityproposals.com) in order to bring to universities the best practices they had learned from the Federal proposal industry. The goal was simple – use what Fortune 500 Federal contractors knew (and used for decades) to help university teams win more awards.

Based in the Washington, DC metro area, Ben and Alison have produced more than 1,000 proposals and oral presentations throughout their careers. They are experts at managing every aspect of a proposal and site visit from development through delivery – including technical and research volumes, pre- and full-proposals, facilitating team writing, peer reviews, orals coaching, site visits, and reverse site visits. They assist Principal Investigators and their teams by providing creative solutions, industry knowledge, guidance, and extensive experience in interpreting RFP and FOA solicitation language and requirements.

Amy Stein, Professor, Levin College of Law, University of Florida

Professor Amy L. Stein is an Associate Professor of Law at the University of Florida Levin School of Law, formerly an Associate Professor at Tulane Law School. She teaches Energy Law and Policy, Environmental Law, Climate Change, and Torts. Professor Stein focuses her scholarship on clean energy law, electric grid governance, distributed energy resources and reliability, environmental law, and federalism. Her recent publications urge regulatory reforms to better harness the reliability benefits of privately-owned reliability resources for the public grid, *Distributed Reliability*, 87U. COLO. L. REV. (*forthcoming 2016*), address the implications of the regulatory uncertainty surrounding energy storage, *Reconsidering Regulatory Uncertainty: Making a Case for Energy Storage*, 41 FLA. ST. U. L. REV. 697 (2014); assess the federal government's role in developing renewable energy, *Renewable Energy Through Agency Action*, 84 U. COLO. L. REV. 651 (2013); analyze the federalism implications of subnational control over siting of electricity generation, *The Tipping Point of Federalism*, 45 CONN. L. REV. 217 (2012); and highlight the deficiencies of climate change analysis in NEPA documents, *Climate Change Under NEPA: Avoiding Cursory Consideration of Greenhouse Gases*, 81 U. COLO. L. REV. 473 (2010), all of which can be accessed at http://ssrn.com/author=1216973.

She has delivered numerous presentations on energy law and policy, including the plenary presentation at the 21st Annual University of Florida Public Interest Conference, and an upcoming keynote at the Florida Energy Systems Consortium's annual conference. She has recently returned from Washington, D.C., where she was invited to present the annual University Advisory Board seminar on *Reliability and the North American Grid* to state senators and representatives from the top energy-producing states. Her work was selected twice for presentation at Columbia Law School's Sabin Colloquium on Innovative Environmental Law Scholarship, as well as for presentation at Minnesota Law School's Legal and Policy Pathways for Energy Innovation conference, University of Texas's Austin Electricity Conference, Northwestern's Searle Center Conference on Electricity Regulation, and the Electric Power Executive Conference. Her current research explores the historic, economic, and environmental implications of regulating electric grid reliability in an era of new reliability resources like energy storage and demand response. Her current work in progress, *Regulating Reliability*, argues for an enhanced focus on utility procurement mechanisms as multi-functioning reliability resources like energy storage and demand response straddle the line between regulatory and market failures.

Professor Stein began her academic career at George Washington University Law School and Tulane Law School. Prior to her academic appointments, she practiced as an environmental and litigation associate for Latham & Watkins LLP in the firm's Washington, D.C., and Silicon Valley offices. She is a member of the District of Columbia, Illinois, and California state bars. She is a graduate of the University of Chicago (AB) and the University of Chicago Law School (JD).

Jeremy Susac, Berger Singerman

Jeremy L. Susac has a broad background in economic and environmental regulation of energy and water. He also has a strong understanding of regulated markets and all aspects of government, including, but not limited to, the legislative process, administrative proceedings, judicial court system and executive branch functions. Jeremy carries hands-on experience with economic development, project management and commercial litigation from his days in N.Y.

Prior to joining Berger Singerman, Jeremy served as president of the Real Energy & Environment Strategies Group, a company providing comprehensive turn-key governmental affairs and consulting services to the energy and environmental industries. In this capacity, Jeremy worked extensively on clean energy, clean tech, and smart grid solutions that included a U.S. Department of Energy smart grid project.

Prior to Real Energy Strategies Group, Jeremy served at every Florida regulatory agency that carries jurisdiction over energy and water – most notably as the Executive Director of the Florida Energy & Climate Commission and the Governor’s Energy Office. In these roles, he developed and coordinated energy policy for State of Florida while simultaneously serving as a critical resource for the Executive Office of the Governor and the Florida Legislature. Mr. Susac began his government service as Senior Attorney at the Florida Public Service Commission (PSC), and eventually climbed his way to a Chief Advisor to a PSC Commissioner. Lastly, Jeremy served as the Director of the Siting Office at the Florida Department of Environmental Protection where oversaw Florida’s permitting process for power plants and transmission lines.

FESC Florida Energy Systems Consortium

ABSTRACTS

Wednesday, May 20- 11:15 am - 12:25 pm
SESSION I: RENEWABLE/ALTERNATIVE POWER, STORAGE, AND EDUCATION ORAL PRESENTATIONS

Track I: Renewable/Alternative Power and Storage

What's "Current" in Ocean Energy – Camille E. Coley, Florida Atlantic University

During June of 2014, Florida Atlantic University's (FAU) Southeast National Marine Renewable Energy Center (SNMREC) signed a five-year lease with the U.S. Department of Interior's Bureau of Ocean Energy Management (BOEM) for approximately 1,068 acres of outer continental shelf lands to research and test ocean current energy conversion technologies. Prior to installation of surface buoys (up to three) used for mooring work vessels which can lower prototype turbines into the water for testing in the Gulf Stream, seafloor surveys must be conducted to ensure that no archaeological or biological resources will be adversely affected. Also, SNMREC has installed two coastal ocean surface radar sites (one at Haulover Beach and one at Hillsboro Beach) which capture surface currents across most of Broward County's offshore areas. This moderator will discuss the progress of the establishment of the first ocean current testing facility to date.

Natural Gas: A Pathway to Low Carbon Motor Fuels - David E. Bruderly, Bruderly Engineering Associates, Inc.

The movement to low-cost, low-carbon natural gas motor fuels could be a major step towards solving Florida's Oil Problem if implemented in ways that achieve environmental and security objectives that are not formally recognized by existing public policy goals or market forces. Jacksonville based businesses in the logistics sector are actively developing both compressed natural gas (CNG) and liquefied (LNG) natural gas motor fuel infrastructure to power cars, trucks, locomotives and ships. In spite of Florida's long history as a pioneer in compressed and cryogenic gaseous fuels, project developers are being forced, out of necessity, to look out-of-state to develop and procure the technology and equipment needed to use this flammable, combustible gas. To date, there has been little, if any, support from the State of Florida to support RDD&D by Florida energy researchers.

For example, CSX has partnered with GE to develop / demonstrate / evaluate the use of LNG fuels to power locomotives. Two shipping companies, Crowley and Sea Star / Tote Marine, have committed billions to build at least four ocean going dual-fuel LNG powered ships to serve the Jacksonville – Puerto Rico trade routes. At least two companies, a Sempra / JEA partnership and Clean Energy, have announced plans to build cryogenic plants in Jacksonville to produce LNG to serve this emerging market demand. The methane could come from renewable sources, such as Florida biomass, in addition to fossil natural gas delivered to Jacksonville via pipeline. The Jacksonville Port Authority, Transportation Planning Organization and Transit Agency are each sponsoring aggressive market development and public outreach and education programs.

This activity could position Florida to leap-frog into a global energy leadership position with respect to the use of gaseous motor fuels. This sudden commercial interest in natural gas motor fuels could be the beginning of a paradigm shift; it could create opportunities for RDD&D to produce, distribute, store and use low-carbon methane and hydrogen much more efficiently and in ways that complement increased use of renewable energy sources. It could create outreach and education opportunities to help consumers regain control of motor fuel markets. While private capital has been earmarked to develop these initial ventures, the focus has been on proven, off-the-shelf technologies and business strategies. The opportunity for investment in RDD&D to support continued improvement in these technologies, not to mention approaches to deployment of infrastructure, has not yet been recognized by Florida academics or policy makers.

Selective Non-Catalytic Reduction (SNCR) in a Diesel Engine - John Nuszkowski, David Armstrong, Samantha Delgado, Matt Furlong, Alex Knapp, C. Reid Shore, University of North Florida

Continual innovation is required to reduce emissions and increase fuel efficiency to displace foreign oil importation. This transformational research addresses the use of Selective Non-Catalytic Reduction (SNCR) as a method to reduce the oxides of nitrogen (NOx) emissions from a diesel engine by injecting urea into the engine cylinder without the presence of a catalyst usually associated with selective catalyst reduction (SCR). Operation of SNCR has been demonstrated through modeling and in exhaust streams to be capable of 80+% NOx reductions. However, only limited research has been done with the application of SNCR to a diesel engine. By implementing an SNCR, a diesel engine could be designed for high fuel efficiency by reducing fuel penalty technologies, such as exhaust gas recirculation (EGR) and delayed fuel injection. This study involved numerical model development, experimental system design and construction, and preliminary SNCR system operation.

Research of heavy-duty diesel engines has been directed at reducing fuel consumption and exhaust emissions of PM and NOx with minimum application of after-treatment system. This study is a SNCR system for a diesel engine, which reduces NOx emissions by injecting a reductant (such as aqueous urea) into to the cylinder. An SNCR system will allow engines to be developed for maximum fuel efficiency without the necessary catalyst of a SCR system. In support of this effort, both experimental and modeling methodologies were used to explore a SNCR system over the engine's operational range. The control parameters of the reductant injection system were explored, such as start of injection and injection duration.

A preliminary single zone model was developed for the SNCR system, which includes the thermal and kinetics processes between the combustion products and the injected reductant. The effects of reductant injection parameters such as start of injection, injection duration, and injection pressure were examined. The kinetic model employed to simulate the reaction process was based on the established mechanisms for n-heptane, NOx-NH3, and urea decomposition.

A single cylinder diesel engine was fitted with a reductant injection system and data acquisition system The reductant injection system is a common rail type injection system (components including a reductant reservoir, high pressure piston pump, and pressure regulator) allowing the exploration of different injection pressures. The reductant was injected during the expansion stroke, after the diesel fuel injection is completed, by controlling the start of reductant injection with respect to the crank angle location. An in-cylinder pressure transducer was installed to calculate the in-cylinder temperature and determine the adequate location for urea injection.

The current research scale engine test cell at UNF's Energy Efficiency Laboratory (EEL) can measure the engine performance, exhaust emissions (NO, NO2, NH3) and combustion process of single cylinder engines. The exhaust temperature was measured at the exhaust port. A NO, NO2 and NH3 analyzer, developed in-house at UNF's EEL, was utilized to measure NOx emissions and any ammonia slip.

Security-Constrained Unit Commitment with Dynamic Ratings – Anna Danandeh, Bo Zeng, Brian Buckley, University of South Florida

Unit commitment (UC) is the most essential problem in power systems, and the uncertainties arose in supply and demand sides add to its complexity. UC problem attempts to schedule generators in a way to meet the forecasted demand with the least commitment and dispatch costs while maintaining various physical, systematical, and reliability requirements. The problem involves two decision making milestones: the status of generators should be determined in a day ahead to accommodate the requirements of long start-up time, and the generation levels and transmission network utilizations will be determined in the real time and is adaptable with the actual load.

Given the importance of reliability in power generating and the high portion of dispatch cost in total operation cost, optimally solving UC problem is imperative. One challenging issue in UC problem is the impact of uncertain factors such as ambient temperature on generation and transmission network capacities. Since system capacity is mostly determined statically, weather changes can cause power outages and/or line congestions. Moreover, actual data reveals load fluctuation with temperature change. To address these issues, we developed a two-stage robust security-constraint unit commitment formulation, which dynamically rates the assets and hedges against possible efficiency drops. Leveraging the correlation between two sources of uncertainty, i.e., weather and load, it yields a less conservative decision and a faster computation. The mathematical model and computational performance will be presented in our poster.

General Capacitor's High Energy Li-ion Capacitors - Jim P. Zheng and Wanjun Cao, FAMU-FSU College of Engineering

General Capacitor (GC) is an FSU spin-off and Tallahassee-based company and focused on development, manufacture, and commercialization of new Li-ion capacitors (LICs) that are destined to play a major role in the world's future energy usage and storage needs. New generation high performance LICs were assembled with activated carbon cathode and hard carbon/lithium stabilized metal power anode. The specific energy and energy density as high as 20 Wh/kg and 38 Wh/L have been achieved, respectively. The LIC obtained a maximum specific power of 7.8 kW/kg. The discharge capacity retention of the LIC at -40 ˚C is about 64% compared to the value at 30 ˚C. After 90,000 cycles, the LIC still have 84% of the initial discharge capacity.

Optimization of $LiMnPO_4$ Using Solid State Processes – Charles Oladimeji, P.L. Moss, FAMU-FSU College of Engineering

The development of lithium ion battery over the years has been in leaps and bound. Research is still ongoing towards the development of better lithium ion batteries and utilization techniques to power devices and machines of the future ranging from hand tools to electric vehicle. Presently $LiCoO_2$ is one of the most commercially available secondary batteries in the market right now.

Among the olivine battery materials $LiFePO_4$ is the most researched and understood material. Other olivine materials have higher energy density but some unfavorable characteristics hinder commercialization. $LiCoPO_4$ and $LiNiPO_4$ have really high voltages that is not in the operating range of presently usable electrolytes. $LiMnPO_4$ is a very promising olivine material, its operating voltage is higher than that of $LiFePO_4$ but still within the operating range of conventional electrolytes.

The low energy density of $LiMnPO_4$ at high rate cycling is a major problem that must be solved before it can be commercialized. Studies have shown that this is due to the low electronic conductivity, large volume change between $LiMnPO_4$ and $MnPO_4$ and high activation resistance.

Many approaches have been applied to solve this problem. The poor electronic conductivity can be alleviated with the use of carbon coating. Using a one-step carbon coating process results in better coating and increased conductivity compared to two step coating. Isovalent co-doping has also been shown to increase the performance of the material. Some other interesting approach to the problem has also been employed. The use of grinding aid to reduce the size of the product has been shown to increase performance. Use of oleic acid during fabrication reduces particle growth and agglomeration. Improved electrochemical performance was also gotten by the use of off stoichiometric mix of the precursor.

The goal of our research is to combine these various methods that has been shown to increase performance of the material then characterize and analysis the material to see if the resulting material would be of higher performance as whole.

Hydrogen Energy Storage for On-Board Fuel Cells, Concentrated Solar Power and Secondary Batteries – <u>Sesha Srinivasan</u>, Ryan Integlia, Jaspreet Dhau, Jorge Vargas, Florida Polytechnic University

Hydrogen is not a primary source of alternative energy like solar and wind. But hydrogen can be derived via various processes such as solar PV, biomass, photo-electrochemical etc. Once produced, an atomic hydrogen behaves like a lean burning fuel in (IC) combustion engines or an active ingredient source for PEM type fuel cells. Usage of hydrogen for stationary and mobile applications not only mitigate the carbon footprints from our atmosphere but also enables energy efficient processes. The role of hydrides because of their temperature swing properties, are currently employed to replace thermochemical energy storage in a concentrated solar power plants. For an electrochemical batteries such as Ni-MH, an added strength of developing light weight hydride electrodes lead for improving the available energy density and the overall battery life as well. Based on the rationale discussed above, this presentation is focused to highlight the salient features of hydrogen based research for fostering project based learning for STEM education and applied research.

Acknowledgments: Authors gratefully acknowledge the FESC for funding this educational project. Authors wish to thank the industrial partners The Mosaic Company for support.

Flywheel Energy Storage for Rural Residential Applications Supplied by Intermittent Wind Power - <u>Ahmed Elsayed</u>, Tarek Youssef, Osama Mohammed, Florida International University

Driven by the environmental concerns and escalating pollution rates, a global trend is initiated towards more deployment and utilization of Renewable Energy Sources (RES). However, one of the impediments facing wide deployments of the RES is their intermittency. For this particular reason, energy storage devices are always attached to RES. For example, wind power farms experience fluctuating wind speeds, consequently the output power fluctuates. In order to smooth this output, energy storage is used. Energy storage can be classified into chemical based including batteries and ultra-capacitors and inertial based as the flywheel. The chemical based ones are not environment friendly and can introduce fire hazard. A known example is the Boeing 787 Dreamliner's which suffered from at least four electrical system problems stemming from its lithium-ion batteries during its first year of service. Another disadvantage is that the chemical based energy storage are characterized by low life time (typically 3000-10,000 charging/discharging cycles). This study introduces the design of an entirely clean power system for rural areas. The utilization of wind turbine system to supply residential loads in an isolated area; i.e. there's no connection to the grid. In order to assure that the entire system is clean and has no negative environmental impacts, a chemical free energy storage is attached to the wind turbine. A flywheel which is sometimes called "electromechanical battery" is used here as a clean energy storage. The operation of the flywheel is simple, it stores the electrical energy in form of kinetic energy in a high inertia rotating mass coupled to an electric machine. This machine is operated as a motor during charging and as a generator during discharging.

The design and proposed topology of the proposed system will be presented. Moreover, simulation results to validate the efficient and reliable performance of the system will be shown and discussed. The simulation results reveal the superior performance of the system. It is successful to cover the loads and continue operation without any reliance on the grid connection. This configuration can help to promote more utilization of wind turbines. The proposed configuration compensates for one of the most disadvantageous properties of wind power which is the high intermittency.

Quest for Grid Energy Storage: Case for the Performance of Iron-Ion/Hydrogen Redox Flow Battery Mixed Electrolytes - Venroy Watson, Derrick Nguyen, Edward E. Effiong, Egwu E. Kal, Florida A & M University

The progression of the Iron-ion/Hydrogen redox flow battery (RFB) system as a cost effective energy system has been impeded by the poor performance of electrolyte. We report here results of an improvement of the RFB electrolyte performance using a mixed electrolyte of iron sulfate and iron chloride and also ammonium iron sulfate and iron chloride. Present results show that the addition of Cl^- increases performance of sulfate electrolyte. Similarly, the performance of the ammonium iron sulfate electrolyte was increased. Charging potential was reduced by about 50% for a mixed electrolytes of iron sulfate 50%(V/V) and iron chloride 50%(V/V) suggesting that a sulfate/chloride electrolyte system can lead to an improved charging/discharging of the Fe-ion/H_2 RFB. Electrolyte performance criteria defined as "electron transfer efficiency" was introduced and using this criterion it was observed that a reverse addition of iron sulfate to iron chloride showed a decrease in the mixed electrolyte's electron transfer efficiency equivalent to a decrease in electrolyte performance. Based on the results, a 100% pure 0.8 M $FeCl_2$ corrosive electrolyte system can be replaced by less corrosive mixture of 46 mol % Cl^- in 0.8 M $FeSO_4$ to achieve the same performance of an all chloride electrolyte system.

Economic Performance of Thermal Energy Storage Integrated with Natural Gas Combined Cycle Power Plants - Barry Osterman-Burgess, Yogi Goswami, Elias Stefanakos, University of South Florida/CERC

This presentation focuses on the economics of integrating thermal energy storage into natural gas combined cycle power plants for improved operational and economic performance of the utility grid. Costs and fuel consumption are modeled based on a Florida electric utility's hour-by-hour load data under two scenarios: 1) no storage, and 2) thermal storage attached to intermediate load, NGCC plants, displacing energy production from older, less efficient NGCT peaking units. Due to the nature of the power grid, several of the older units feature abnormally high fuel costs and abnormally low thermal efficiencies. By shifting load from the most expensive peaking units to more cost-effective combined cycles with a 204 MWhth storage system costing about $4 million, savings of more than $1 million per year can be realized while also reducing CO_2 emissions by about 5000 metric tons per year. These savings represent an internal rate of returns of up to 23% over a 30-year lifetime, depending on the initial cost of the storage system.

FAMU Spheromak: Fusion Energy for Distributed Energy Resources - Jerry Clark, Charles A. Weatherford, Ronald Williams, Florida A & M University

The FAMU Spheromak Turbulent Physics Experiment (STPX) is a toroidal confinement plasma where the magnetic fields are produced by currents in the plasma and the toroidal field disappears at the wall. STPX, the world's largest spheromak reactor, is a high-temperature plasma device that achieved first plasma on July 17, 2012, with plasma temperatures of 300 eV and 600 kA plasma currents. We propose to deploy modular fusion reactors--Spheromaks--as distributed energy resources (DERs) and integrate them into the smart grid. The Spheromaks would be deployed throughout the national transportation system as power sources, in conjunction with other types of DERs such as solar, wind, and smart roadways with integrated solar cells, to provide power to car charging stations and battery farms.

Renewable Cities: Technology, Goals, and Implementation - Santiago Arias, Darren Brandes, Christopher Brown, Caroline Mayer, Fazil T. Najafi, University of Florida

Literature search was conducted on the current state of the concept of "renewable cities," including the technology used, goals that have been set, and cities that are at the forefront of implementation. A paper was developed and looked at the question and an overview of why there is a push to make cities renewable and sustainable. The benefits are financial, environmental, and social in nature. Next, the sustainable technologies and practices that are currently being used in renewable cities, and ones that have been proposed, and was examined. Following this, the paper looked at the various organizations that are advocating for renewable cities, and the goals they have set. This also include discussion of criticisms of the concept. Finally, the paper looked at cities that are currently implementing renewable practices, including the flagship Masdar City in the United Arab Emirates, which was under-construction, the city that was designed to be fully sustainable. While Masdar City has had to scale back its ambitions, and Tianjin has set lower, more achievable goals, they are both proof that the technology can be implemented. Concern remains, however, over the costs. The best and most effective solution, perhaps, may be to implement renewable city design practices in today's cities. Incremental improvement in existing cities and implementation of best practices as urban areas expand will, of course, be more achievable than building new, expensive cities from scratch.

Renewable cities can utilize renewable energy. The solar panel is a widespread, easy to install and maintain renewable energy technology. It's used everywhere from residential roofs to the renewable cities of the future. For example, in Masdar City, there is an 87,777 panel, 10-megawatt field of solar panels, along with building-mounted solar panels, and demand is kept in check by an impressive array of design features that minimize the need for air conditioning despite the hot desert locale. Depending on area's location, for instance, cities near a coast would benefit from wave power, from which the U.S. Department of Energy (DoE) has estimated that 1,420 terawatt-hours of electricity could be captured per year. Cities in plains areas could take advantage of the ample wind energy. Geothermal power would be advantageous in areas with geologic formations that would allow cost efficient installation of these power generation plants, which the U.S. DOE has estimated can provide 130 gigawatts of power. With more cities implementing energy sources likes these, reliance on polluting, carbon producing fossil fuels would greatly be reduced. However, as models of ambitious goals, funded by nations with the desire and resources to develop them, renewable cities can represent the cutting-edge of what's possible.

A Systems Engineering Model for Harvesting Electricity from Shallow Water Tidal Currents - John Domenech, Tim Eveleigh, George Washington University

Federally proposed carbon emission reductions, retirement of aging power plants and a population increase of about 15M people by 2040 are expected contributors for outstripping domestic regional electricity production in five southeastern states (South Carolina, Georgia, Florida, Alabama and Mississippi). For these particular states, projections at 2040 show a population of about 56 million and an anticipated electricity shortage of about 15,000 megawatts. Alternative renewable energy sources, such as shallow water tidal currents, represent possible considerations for closing the expected shortfall.

From 2012-13, the World Meteorological Organization reported that atmospheric carbon dioxide concentration increased by 2.9 ppm to 396.0 ppm, a relative increase of 0.74% compared to the mean annual absolute increase of 2.07 ppm during the last 10 years. Separately, but due to increasing rates of CO_2 concentration, the United States Environmental Protection Agency proposed regulatory reductions of about 30% by 2030. Concurrent yet disparate factors of increasing atmospheric CO_2 concentration combined with mandated reductions, retirement of aging power plants, and population increases add to the looming resource problem of choosing which alternative energy sources are best able to help close the gap between electricity supply and demand for these states. Continuous and predictable shallow water tidal currents (<15m deep), as yet exploited to a serious extent, represent excellent opportunities for exploration and possible exploitation of a promising resource from which to convert kinetic energy into mechanical energy to drive generators and produce electricity.

The proposed systems engineering model incorporates variables such as current speed, distance to the grid, turbine type, permitting, and cost of development to name a few. Examination, using factor analysis to determine correlation between variables, aids the discovery as to which variables have the greatest impact on the model. The proposed process model yields a numerical rating between 0-10 indicating whether one should consider applying financial resources to develop the tidal current resource against a given location. Output values 1-3 indicate a low or unlikely positive return on investment, 4-7 a neutral return on investment and 8-10 a likely positive return on investment. Model use provides decision makers (entrepreneurs, electricity generating companies, state and federal level resource managers, etc.) a means of quickly determining whether and where tidal currents represent opportunity to cost-effectively harvest electricity and potentially reduce the exigency associated with projected electricity supply and demand disequilibrium.

Track II: Education

Solar Energy Technologies: Fundamentals and Applications in Buildings - Cheng-Xian (Charlie) Lin, Florida International University

Funded by FESC, Florida International University will develop a new online course in solar energy technologies, with emphasis on solar applications in buildings, taking into account the unique solar resource and infrastructure in the state of Florida. The new online course will be offered through the Department of Mechanical and Material Engineering at FIU. The course will be delivered completely online through FIU's Blackboard Learn system. The scope of the course will cover the solar technology applications in buildings for electrical power and thermal energy generations with focus on integrations in heating and cooling systems. The course targets senior undergraduate students and entry level graduate students who study in FIU as well as other universities in the state of Florida. The course will be offered at least once a year. Students will earn 3 credit hours by taking the course in the Spring, Fall, and/or Summer semesters. Currently, the PI is in the process of preparing the teaching materials.

Buildings and Energy: Design and Operation vs. Sustainability: an Energy Engineering Course for Florida-specific Building Design & Operation – Prabir Barooah, Duzgun Agdas, Ravi Srinivasan, University of Florida

The course "Buildings and Energy: Design and Operation vs. Sustainability" was designed with financial support from FESC in the form of an educational grant, and taught for the first time in Fall 2014. To achieve higher standards in building design and operation, a solid foundation of energy engineering and sustainability principles is essential. While there are a number of courses on the individual disciplines that affect building design and operation, there is no unifying course. At UF engineering in particular, there are no courses offered to students and industry professionals in energy topics particularly related to buildings, specifically for the design and operation in Florida climate conditions. This project fills this void through the development of an energy engineering course. The course was positively received by both undergraduates and graduate students who were enrolled in the Fall 2014 offering. Lessons learned from this first experience will be discussed.

Renewable Energy Courses for Master's in Global Sustainability - George Philippidis, USF Patel College of Global Sustainability

USF's Patel College of Global Sustainability has created a Renewable Energy concentration track for students pursuing their M.A. in Global Sustainability. The energy track's goal is to make Florida a national leader in educating, training, and preparing students for the green energy jobs of today and tomorrow. The new track was offered for the first time during the 2014-15 academic year. It consists of two graduate courses (3 credit hours each) that address the two forms of renewable energy, fuels and power.

The courses, "Renewable Transportation Fuels" (in Fall) and "Renewable Power Portfolio" (in Spring), are offered both on-campus and on-line. The goal of the fuels course is to educate students about the technology, business, economics, financing, sustainability, and policy aspects of renewable fuels for vehicles and the aviation sector with emphasis on advanced biofuels. The goal of the power course is to educate students about the technology, business, economics, financing, sustainability, and policy aspects of renewable power production from solar, wind, geothermal, biomass, and ocean sources, renewable power storage, and smart grid. The courses were designed and are taught by faculty with expertise in renewable energy and involve the participation of invited guest speakers from industry that are renewable energy experts to enrich the students' exposure to real-world problems and provide them with practical career development advice. A semester-long research project on a renewable energy subject provides students with the opportunity to apply research methodologies and study in depth the particular energy theme of their choice. Course evaluations are conducted using surveys developed specifically for these courses in collaboration with USF's Department of Industrial Engineering.

Renewable Energies and Sustainability Education - Ryan Integlia, Sesha Srinivasan, Gary Albarelli, Brian Birky, Jorge Vergas, Jaspreet Dhau, Ghazi Darkazalli, Florida Polytechnic University

This education project is aimed at developing a stand-alone course content accessibility, conducting competitions and workshop that can be offered to undergraduate and graduate students at the Florida Polytechnic University as an elective. The proposed course "Renewable Energy Systems and Sustainability" (EEL 3287) is part of new discovery track of courses which will discuss a wide range of energy, sustainability and related applications, which will reflect on the various physical or online resources and how the hybridization of technologies will produce new opportunities for economic development. Some of the topics discussed include harvesting, renewability, sustainability, storage, materials utilization, renewable energy and sustainability entrepreneurship, smart grid and infrastructure integration. This course will create awareness and engagement of various renewable energy systems, technologies promoting sustainable, and economic development concepts supporting entrepreneurship among students and industry that impacts the workforce and the economy of Florida. Four undergraduate research projects in development at FL Poly are (i) 3D printing technology and Sustainability, (ii) smart solar electric vehicle, (iii) water purification using solar photocatalysis and (iv) hydrogen storage materials development for PEM fuel cells. This FESC funded educational project will have a positive impact on the academic community of undergraduate and graduate students and possibly general public, as well as potentially strengthening the research/curriculum capabilities of Florida Polytechnic University. This project will help the Florida Polytechnic University in establishing a track record in the field of STEM based research and also serve as a spring board to produce and solicit future grants for continuing research that will benefit our diverse student population.

Cultivating Change: Using Social Marketing to Encourage Environmental Behaviors - Laura A. Warner and Kathryn A. Stofer, University of Florida

A substantial number of energy-savings technologies and techniques are readily available, yet the rate of adoption in commercial and residential settings has been slow (McKenzie-Mohr, 1994). Most programs that encourage sustainability focus on simply increasing public knowledge, despite the fact that information alone has been shown to only minimally affect behavior change (Frisk & Larson, 2011; McKenzie-Mohr, 200; McKenzie-Mohr, 2011). To realize actual behavior change, a more strategic approach is required, and outreach educators are encouraged to focus on behavior change when seeking to improve sustainability in their communities.

Social marketing is a proven approach to creating behavior change, and is highly applicable to Extension and adult educational efforts (Rogers, 2003; Skelly, 2005). This approach applies principles of traditional marketing to influencing individuals' behaviors to benefit themselves and the community in which they live (Kotler & Lee, 2008; McKenzie-Mohr, 2011). Social marketing has been used successfully for a number of energy-saving campaigns.

Despite the fact that social marketing has been used extensively for decades in community health campaigns, and has more recently been used in successful environmental sustainability initiatives, many outreach professionals are unaware of this approach or unknowledgeable about how to apply it to their programs. There is a dearth of available training for outreach professionals on social marketing and other behavior change approaches. Therefore, the certificate in Cultivating Change is being developed to provide Extension professionals and other energy educators with the background and knowledge needed to apply social marketing principles to existing and future programs. This certificate program seeks to increase awareness of the major principles and tools that guide social marketing and increase participants' ability to apply this strategy to energy outreach programming.

This presentation will describe the online, self-paced certificate program targeting Extension and other educational professionals who conduct outreach education to encourage energy conservation. The aim of this educational offering is to improve the process of program delivery focused on sustainable behavior change within the context of energy usage. Ultimately, improved delivery strategies will increase the adoption of behavior change related to energy and other limited resource use.

This educational program will be offered to environmental educators who work for a variety of institutions throughout Florida, including outreach professionals who work for utility providers, local government, nonprofit organizations, and solar power companies; energy teachers; and Extension educators who encourage the sustainable use of energy, water, and other limited resources. A pilot test of the program has been completed and feedback has been positive. Pilot test participants' recommendations are being incorporated into the final version of the certificate program, which is slated to be completed in Spring of 2015.

Educating on Economic Realities of Sustainable Energy – Michelle Phillips, Mark Jamison, University of Florida Public Utility Research Center

FESC has provided funding to UF's Public Utility Research Center to create a class for upper level undergraduates on the economics of energy sustainability. The class is funded for two offerings. Energy sustainability is a popular topic, but fact-based and analytically rigorous discussions of the economic realities are rare. Florida students and other Floridians need to understand these realities so that they can make sound business and career decisions and to be informed citizens. The first offering of the class was taught at the University of Florida in the Fall of 2014 term. Four research papers from the Fall 2014 class were selected for a moderated session at the Bob Graham Center for Public Service. The session involved paper presentations by undergraduate students and answering questions from attendees. The topics presented were: (1) Ocean currents as a renewable resource for Florida, (2) Time to consider solar for sunshine sports, (3) Lack of sustainability in agriculture, and (4) Florida energy problems, options, and possible solutions. The current offering of the course is being video recorded and will be made available to Floridians for continuing education certificates. Topics covered in the course include: market structures, cost benefit analysis, tradable permits, subsidies, energy efficiency, economics of renewables, and transportation.

Educational Modules in Support of Sustainable Energy Courses - J.C. Ordonez, Sam Yang, M.B. Chagas, K. Ribeiro, C. Ordonez, T. Solano, J.V.C. Vargas, H. Li, Energy and Sustainability Center

A series of educational modules on sustainable energy are proposed. The modules will be incorporated initially into existing courses in sustainable energy, thermal fluids and senior design at the FAMU-FSU College of Engineering and later components will be used in non-engineering courses on sustainable energy. The proposed modules emphasize on real systems and devices to elaborate on relevant aspects of sustainable energy. In particular, we propose to develop the modules around FSU's Off-Grid Zero Emissions Building (OGZEB), which serves as an energy efficient prototype for developing and testing sustainable energy technologies in residential settings. The modules will refer to the OGZEB and use its systems to illustrate different concepts. This will provide continuity to the material, and motivate students through exposure to concrete systems. The initial modules will cover solar photovoltaic systems and microalgae for biodiesel.

The solar photovoltaic module will cover videos on solar irradiance measures, solar tracking and power converters for PV systems. The microalgae module will have videos illustrating the stages of the microalgae cultivation process and biomass extraction.

Matching Training to Industry Needs - <u>Nina Stokes,</u> Marilyn Barger, Richard Gilbert, FLATE

In 2008, Florida's legislature directed, via FESC, the Florida Energy Systems Consortium, the State's University and College system to develop applied research and specific technical education pathways to allow Florida to meet its 2020 energy generation and demand criteria. The current strategy is entertaining a mix of conventional, nuclear, solar and bio-fuels for generation and a range of options to make Florida "green" within a "smart" grid. In that same legislative action, FLATE, the National Science Foundation Advanced Technological Education Center of Excellence for Florida, was commissioned to partner with FESC to prepare and execute a technician workforce plan that will put that energy workforce into place on time. This presentation will cover the history of this grant and related outcomes since its start in 2008. This will include recent work on sustainability staffing in Florida colleges, and on the current effort to help facilitate the development of a trained and skilled workforce capable of implementing a national clean-energy smart grid and providing for the next generation of skilled technicians, engineers and managers for the electric power industry.

The University of Florida Training Reactor: Powering Nuclear Education & Innovation - <u>Shannon L. Eggers</u>, Kelly A. Jordan, University of Florida

The University of Florida Nuclear Engineering Program (NEP) has seven primary faculty, five affiliated faculty, 100 enrolled undergraduate majors, and 40 masters and doctoral students. The departmental facilities include the University of Florida Training Reactor (UFTR), a uranium metal-fueled sub-critical facility, a high-output fusion neutron generator irradiation laboratory, 1 and 10 curie Plutonium-Beryllium neutron sources, a radiochemistry laboratory with a hot-cell and decontamination capabilities, a neutron activation analysis laboratory, and multi-user nuclear instrumentation laboratory work stations.

The UFTR was designed and is used primarily for training and nuclear research related activities. The UFTR is a light water and graphite moderated, graphite reflected, light water cooled reactor of modified Argonaut-type licensed for 100 kWth power operation. The UFTR recently resumed operations after a multi-year facility refurbishment to upgrade the physical infrastructure, including new low enrichment uranium (LEU) fuel, nuclear instrumentation systems, process instrumentation replacement of the HVAC systems, physical security systems, and reactor instrumentation and control (I&C) systems. This refurbishment and ongoing project to add digital I&C systems will ensure the UFTR will remain operational for another 40+ years.

The UFTR offers unique capabilities for training students enrolled at UF and other educational institutions as well as industry employees. Courses include a Radiation Detection Lab, Neutronics Lab, Reactor Experiments Lab, and Reactor Operations Lab. The Reactor Operations Lab provides industry and university student hands-on training on reactor operations, including in-depth experiments on reactivity and reactivity feedback effects. Advanced topics include: reactor startups and shutdowns, power operation and temperature coefficients, reactivity manipulations and heat balance, criticality configurations and delayed neutrons, and transient and abnormal operations.

The Radiation Detection Lab is a comprehensive laboratory survey of the detection of ionizing radiation, sources, and associated electronics; the Neutronics Lab includes a hands-on introduction to the production and detection of neutrons; and the Reactor Experiments Lab includes reactor specific measurements focusing on experiments of fundamental importance to nuclear operation such as approach to critical, neutron flux, and neutron activation analysis.

Save Money: Be a Savvy Consumer of Energy - Heidi Copeland, Will Sheftall, Bob Seaton, University of Florida-IFAS Extension

Can consumers really make choices that change their behavior and result in saving both money and energy? This stand-alone "lunch and learn" is less formal and less structured than normal. Nonetheless, this training helps people understand that their personal behavior, in regards to consuming energy, can result in big savings of both money and energy.

Using the terms savvy and saving simultaneously can be a compelling reason for consumers to take a look at their behavior. Taking a personal look at behavior is important as people need to understand what is influencing their conduct and why making a change can be to their advantage.

A consumer's purchasing behavior can be: cultural, social, personal as well as psychological. *Save Money: Be a Savvy Consumer of Energy* touches on all of this while at the same time attempting to change personal energy consumption highlighting how personal behavior provides an ENORMOUS benefit both in saving energy and money at no financial cost.

Participants also increase their knowledge about small investments that can provide short Returns on Investment (ROI) if installed correctly and used efficiently. *Save Money: Be a Savvy Consumer of Energy* also mentions the many ways a savvy consumer can spend money to save both money and energy.

Influencing a consumer behavior through face-to-face contact allows individuals the chance to ask questions as well as be influenced by their peers. Consumers that learn in a non-threatening environment begin to pre-contemplate as well as contemplate the individual changes they can make.

True valuation can be measured when individuals take action to decrease their consumption of energy as their new behavior soon becomes their new normal.

Change happens. What better way to change than to engage in a more sustainable lifestyle with less consumption of earth's limited resources.

Developing Leaders for a Sustainable Future - Linda Seals, Holly Abeels, Gayle Whitworth, University of Florida-IFAS Extension Brevard County

The UF/IFAS Extension Sustainable Floridians^{SM} program combines the knowledge base of university experts with a discussion and action format designed to help individuals take steps toward sustainability. Participants learn how to reduce resource consumption, save money, and become part of a transition to a more environmentally, socially and economically sustainable future. In the fall of 2014, UF/IFAS Extension in Brevard County delivered the program to 24 participants. Participants learned about various topics related to sustainability including energy, transportation, food systems, water, climate change, and consumerism. Additionally, the first and last sessions focused on why and how to be advocates for sustainability. Participants learned how to affect change in their community by removing barriers to change, critiquing information they receive, i.e., check for scientific accuracy, communicating with diverse audiences more effectively, and becoming more motivated and inspired to take on leadership roles within their community. At the end of the program, the majority of the participants agreed to meet bimonthly to continue networking with each other and with Extension faculty. The participants indicated they want to learn more about how to make a difference in their community by becoming agents of change. These meetings will consist of discussions on subject matter related to sustainability, community projects, sustainability action plans, and volunteer opportunities. Currently, many of the participants have taken action in their community by organizing or volunteering for sustainability events.

Wednesday, May 20- 3:30 pm – 4:40 pm
SESSION II: BIOMASS AND SOLAR ENERGY ORAL PRESENTATIONS

Track I: Biomass

Development and Scale-Up of a Horizontal Bioreactor for High-Density Cultivation of Microalgae - Ioannis Dogaris, Michael Welch, Bethany Loya, Andreas Meiser, Lawrence Walmsley, George Philippidis, University of South Florida

Algae represent a substantial source of biomass with the potential to revolutionize the manufacture of bio-based products, including renewable transportation fuels and a variety of chemicals. Important techno-economic challenges are still to be addressed, such as low-cost production, downstream processing, and conversion to end products. Currently, large-scale algae operations depend on open ponds that experience low productivity and are vulnerable to contamination. Moreover, water and energy usage needs to be minimized to promote sustainable development. Hence, low-cost and high-efficiency microalgal cultivation systems are highly desirable. We present the design and scale-up of a horizontal bioreactor (HBR) for algae production. The HBR is scalable and low-cost, as it is modular and manufactured from inexpensive plastic film. By design it reduces water usage by 4-fold over open pond systems and minimizes the risk of contamination. The operation of a 65-L floating HBR prototype was previously demonstrated indoors and outdoors with high biomass productivities. An improved 150-L HBR prototype was designed and successfully deployed. High-density growth of the marine microalgae Nannochloris oculata was achieved without contamination issues. The energy consumption for culture mixing and CO_2 provision has been reduced significantly by replacing the airlift module with a paddlewheel and gas micro-diffusers. Currently, the deployment of a 2,000-L scale-up version of the unit in an outdoor pond is underway to demonstrate commercial feasibility and assess the financial performance of the technology. Algae growth monitoring and remote control systems have been incorporated into the HBR and hydraulic testing of the unit has been performed to confirm its functionality. Semi-continuous operation is currently in progress.

Cultivation and Optimization of Saline Microalgae BG0011 for Production of Biofuels and Bioproducts - Yingxiu Zhang, Tung Chen, Vincent Ferron, Cesar M Moreira, Spyros Svoronos, Edward Phlips, Pratap Pullammanappallil, University of Florida

Synechococcus BG0011, a cyanobacterium isolated from a shallow lake in the Florida Keys possesses some unique characteristics which makes it an attractive candidate for production of biofuels and bioproducts. It can fix nitrogen, tolerate high salinity and secrete an extracellular biomaterial (ECB) which contains proteins and carbohydrates. Several factors can affect microalgae growth. The effect of light intensity, CO_2 concentration, phosphorous concentration, and type of pH buffer were investigated in this study. Four, 500mL modified Pyrex glass bottles were used as photobioreactors (PBRs) for batch cultures. PBRs were sparged with sterile humidified air at 0.5L/min with different CO_2 concentration. Cultures were exposed to 13/11 hour light/dark cycle using artificial lights. Temperature was 30±2°C during light cycle and 22±2°C during dark cycle. In all experiments inoculation was followed by a lag phase, an exponential growth phase and eventually a stationary phase. ECB production was initiated in late exponential phase and continued to be produced even after the growth had reached stationary phase. Dry weight and volatile solids measurements on centrifuged and separated biomass pellet and supernatant were used to quantify biomass and ECB production. Initial experiments were carried out using 4-(2-hydroxyethyl)-1-piperazineethanesulfonic acid (HEPES) which is an expensive organic buffer and serves well for microcosm experiments. But it is not an economical option for large scale cultivation. HEPES was replaced with $NaHCO_3$. It was confirmed from long term cultivation using $NaHCO_3$ buffer, that pH was maintained at

7.5±0.25°C, and cell density, specific growth rate and ECB concentration was not different to that obtained using HEPES buffer. Increasing light intensity increased algae cell density and maximum specific growth rate (µmax). At low light intensity (60µmol photonm-2s-1) cultures sparged with a mixture of air and 1% CO_2 reached 0.74g/L of biomass after two weeks of cultivation. Upon increasing the light intensity to 1200µmol photon m-2s-1, cell density increased to 2.2g/L of biomass. µmax also increased from 0.33day-1 to 0.55day-1 when increasing light intensity. Another experiment with five different light intensities have shown that before reaching the light intensity saturation point, µmax is proportional to the light intensity. Under low light, increasing CO_2 content of air does not improve cell density or maximum specific growth rate. But at the higher light intensity, cell density increased from 1.0g/L to 2.2g/L when air was enriched with 1% CO_2. However, µmax was not affected. Cell density was not improved at 5% CO2 compared to 1% CO_2. The effect of phosphorus was studied at concentrations of 0.012, 0.024, 0.05 and 0.1g/L of K_2HPO_4. µmax was 0.26, 0.33, 0.69, 0.58 day-1, biomass dry weight was 1.8, 2.3, 3.7, 3.9g/L and ECB dry weight was 3.2, 4.1, 4.4, 4.0g/L respectively. The result shows that, as phosphorous concentration increases, cell density increases but ECB content does not increase appreciably. After two-month cultivation, nearly 4g/L of biomass and about 4g/L of ECB can be produced, that is, a total 8g/L of organic matter is obtained which can be used as feedstock for biofuels and bioproducts.

Introducing a Membrane Photobioreactor for Cultivating Microalgal Biofuels in Wastewater - Ivy Drexler, M Pickett, DH Yeh, University of South Florida

A patent-pending method, the Isolated Cultivation of Algal Resource Utilizing Selectivity (ICARUS), to cultivate microalgae in wastewater is introduced. The photobioreactor is a hybrid open/closed system, where the bottom of the ICARUS reactor is a membrane. The membrane bottom restricts the passage of invasive organisms (i.e., grazers, competitors), protecting the algal crop from infection and contamination. Enhanced crop protection allows high value biofuel species to be cultivated using wastewater, a virtually impossible feat without ICARUS. The sub-micron porous barrier allows the free passage of water and dissolved constituents (CO_2, N, P) and decouples the culture from the growth medium, increasing the nutrient pool. It shields the culture from shock loads and fluctuations in quality due to dampening by mass transfer. Wastewater is a near infinite sink for waste products (such as O_2) and regulates culture temperature and pH. The reactor floats in existing infrastructure (wastewater tanks), capitalizing on typically restricted space.

Initial proof-of-concept screening of eleven membranes of varying porosity and materials compared algal productivity in ICARUS to that of cultures suspended directly in media. In many cases, ICARUS had a significantly higher final cell density than control cultures. The initial screening also hinted at pH regulation and crop protection, which were tested in extended field conditions. Three membrane types were trialed in ICARUS reactors floated in a wastewater clarifier for three weeks. The homogeneity of the algal culture was maintained in membranes of lower pore size, demonstrating the technology's ability to safely cultivate a high value crop in wastewater. Dissolved constituents moved freely across the membrane, and ICARUS promoted a higher cell density and longer exponential growth phase than control cultures. ICARUS achieved twice the cell density typically seen in closed photobioreactors (4 g L-1, Chisti, 2007); higher cell density is important in reducing downstream harvesting and dewatering efforts for biofuel processing.

Modelling efforts have estimated biomass productivity, nutrient removal, and biofuel production. The predictions assume installation of ICARUS reactors at various treatment stages at the local wastewater treatment plant (Tampa, FL) where initial field studies occurred. Field data was used, when available, for biomass productivity and wastewater quality, and literature values were used to extrapolate nutrient uptake and cost savings. Assuming a biomass productivity rate of 19 g m-2 day-1 (field data), it is estimated that the surface area provided by the secondary (10752 m2) and tertiary (7848 m2) clarifiers would produce more than 100,000 kg of biomass annually, a typical target of large-scale biofuel production facilities. Utilizing all available space (1°, 2°, 3° clarifiers and the nitrification basins) could yield more than 143,000 kg of biomass per year. Wastewater nutrients (N, P, CO_2) were found to be in excess, even at higher assumed productivities. Due to the development of the ICARUS cultivation method, where high value algal crops remain protected from competing biology, the existing infrastructure of wastewater treatment plants can become a substantial contributor to algal biofuel production.

Industrial Sweetpotato and Energybeet Potential for Biofuel Feedstocks in South Florida - Brian Boman, Edward Evans, Ann Wilkie, Janie Ryan-Bohac, University of Florida - Indian River REC

This project is investigating the potential for energybeets and industrial sweetpotatoes as feedstocks for biofuels and biogas in South Florida. A major goal of the studies is to determine if these crops might be part of economically viable industry as replacement for several hundred thousand acres of citrus that has been taken out of production due to huanglongbìng (HLB) disease. On-going field trials at the Indian River Research and Education center are documenting cultural operations, input costs, and potential yields for these crops grown on sandy, flatwoods soils. These data, along with lessons learned for energybeet trials conducted during the 2013/2014 winter season and for summer 2015 sweetpotato crops are presented. In addition, preliminary data from lab studies looking at optimizing processes to convert sweetpotatoes to ethanol provide promise for the long-term viability of these feedstocks as feedstocks. The establishment of a biofuel industry based on these two crops has the potential to significantly benefit regional and local communities and to provide enormous gains for agriculture, especially in areas where diseases have taken out citrus groves.

Evaluating the Bioenergy Potential of Sweetpotato Vines - Wendy A. Mussoline, Ann C. Wilkie, University of Florida/IFAS Extension

Sweetpotato is a relatively low maintenance, high-yielding crop that can be used for human consumption or biofuel production. Varying perspectives exist on whether sweetpotatoes should be grown for food or fuel. However, the value of the vines, the aerial portion of the plant, is rarely considered. Sweetpotato vines are often discarded but can be used for human consumption, animal fodder, or bioenergy. Vines represent an agricultural residue that is readily available as a feedstock for anaerobic digestion to produce methane. The agronomic yield of aerial vines varies widely depending on the variety, the region, soil type, time to harvest and irrigation schedule. To maximize the full potential of the sweetpotato crop, the vines must be utilized. The objectives of this study were to measure the agronomic vine yield of three different sweetpotato varieties and to evaluate their methane potential to determine which variety should be selected to promote the highest energy recovery from the vines.

A field trial was conducted in Gainesville, Florida to determine vine yields from two table sweetpotato varieties (Hernandez and Beauregard) and one industrial variety bred specifically for ethanol production (CX-1). Thirty-two unrooted vine cuttings were planted 1 foot apart in a raised bed, with three replications, for each variety. Soils were identified as a loamy Blichton sand, gently sloping and poorly drained. Fertilizer (N:P:K-6:6:6) was applied at 1400 lbs/acre and rainfall was 30 inches with no additional irrigation. The vines were harvested by hand 165 days after planting and weighed to determine vine yields. Following harvest, the vines were dried, milled to 0.85 mm, analyzed for in-vitro organic matter digestibility (IVOMD) and nitrogen (N), and evaluated for methane potential. Methane index potential (MIP) batch assays were conducted in triplicate at mesophilic (35ºC) temperature for a total of 30 days.

Fresh vine yields for the CX-1, Hernandez and Beauregard cultivars were 20.0, 19.3, and 11.6 tons/acre, respectively. The vine yield to root yield ratio on a DM basis was 1.64:1 for CX-1, 1.50:1 for Hernandez, and 0.65:1 for Beauregard. These results indicate that vine yields vary based on the variety, even when all other environmental factors are consistent. Based on the vine yield combined with the vine-to-root ratios, the CX-1 variety is preferred in terms of maximum biomass production.

The methane potential of the vines depends on several factors including the organic fraction and degradability of the material. The organic fraction, or volatile solids (VS) concentration, for all three varieties was the same (89% DM). The portion of the organic matter that is digestible within the context of a ruminant is represented by the IVOMD, which was highest for the CX-1 vines (75%) compared to Hernandez (62%) and Beauregard (64%). The methane yield obtained from the MIP assays was also highest for the CX-1 vines. The N concentration was the same for all three, so the digested material would contain the same essential nutrient concentrations for use as a fertilizer. Therefore, the CX-1 variety is the most advantageous for utilization of the vines as bioenergy feedstock.

Florida Farm to Fly – Advanced Biofuel Feedstock Supply Chain Integration – Ben Devries, Treasure Coast Research Park

The Treasure Coast Research Park (TCRP) in Ft. Pierce, FL is working closely with UF IFAS, FAA-CAAFI, and USDA RD to expand advanced biofuel (ABF) feedstock cultivation and processing technologies with the express goal of expanding rural employment and agriculture production. TCRP has initiated three programs to facilitate ABF sugar and starch crop feedstock cultivation and processing:

1.) In collaboration with FESC, TCRP convened the ABF Feedstock Certification Working Group. This Working Group is focused on validating multi-year crop rotations and agronomy for commercial production of ABF sugar and starch crop feedstock; and securing EPA certification of industrial sugar and starch crop feedstock under EPA's Renewable Fuel Standard 2.0.
2.) In collaboration with FAA CAAFI and USDA RD, TCRP is leading the "Florida Farm to Fly" market research program to identify barriers to expanding ABF cultivation and processing in Florida faced by the transportation and agriculture industries.
3.) In collaboration with UF IFAS and USDA ARS, TCRP established an industrial sugar and starch crop ABF feedstock cultivation and processing demonstration facility on 120 acres within TCRP. This facility will operate in collaboration with existing Florida research programs to foster grower adoption of the latest hybrid sugar and starch crop feedstock, cultivation and commercial handling practices.

This presentation will provide background on the Treasure Coast Research Park, the transportation industry's need for advanced biofuels, the potential market opportunity and identified barriers to expanding the ABF supply chain in Florida.

Reinvigorating Oleoresin Collection in the Southeastern USA: Evaluation of Stand Management and Tree Characteristics with Borehole Tapping - J. Lauture, Gary Peter, A. Hodges, University of Florida

The borehole tapping method was used to extract oleoresin from the xylem in slash pine (*Pinus elliottii*) in North Florida. This closed collection system allows for the recovery of higher quality resin, which can be used for a variety of commercial products as well as a natural liquid biofuel. Conifers produce oleoresin naturally as a biochemical defense against plant pests, such as boring bark beetles. The objectives of this project are to develop cost effective methods to collect oleoresin in North Florida and assess the feasibility and impact of expanding collection of pine terpenes for renewable chemicals and biofuel production on a large-scale. Treatments were applied manually using a gas powered drill as well as with an automated drilling machine mounted on a tractor designed to drill 3 connecting boreholes at the base of the tree.

Oleoresin yields were compared from North Florida slash pine plantations aged 11, 15, and 22 years collected in the summer and fall. Oleoresin yields increased with stand age and DBH, as well as in stands managed for pine straw raking. Methyl jasmonate stimulated higher rates of oleoresin production compared to all other chemical stimulants.

An Intensified Process for Production of Liquid Hydrocarbon Fuels From Biogas to Overcome BGTL Economy of Scale Challenges - Nada Elsayed, Babu Joseph, John Kuhn, University of South Florida

The growing energy demand along with the inevitable depletion of fossil fuels warrants finding alternative fuel options. Biogas from degradation of municipal solid waste and other sources of biomass is considered here as a renewable potential carbon neutral source for conversion to value-added products in high demand such as diesel fuel. One main challenge with biogas-to-liquid (BGTL) technology is the issue of scale, which warrants large scale facilities to achieve profitability. However, large scale facilities is not congruent with landfill gas and biogas. The second major challenge is contaminant removal prior to processing. The current research addresses one of the primary "show-stoppers" preventing the first challenge of small-scale distributed BGTL facilities, which is the conversion of biogas (primarily methane and carbon dioxide) to syngas (H_2 and CO) at temperatures similar to the fuel synthesis. Our results showed that Pt and Pd doped Ni-Mg/(Ce0.6Zr0.4)O_2 catalysts are able to achieve substantial conversion of CH_4 and CO_2 at temperatures approaching those of the fuel synthesis process. With these promising findings, we are currently synthesizing a composite catalyst that also contains a conventional Fe-based catalysts for the fuel synthesis, to test in the intensified process. It is anticipated that the mass and energy integration achieved by the intensified process will substantially enhance the techno-economic feasibility of BGTL technologies.

Adaptation of Mesophilic and Thermophilic Anaerobic Digester to Salinity - Doan, Nguyet, Cabrol, L., Moreira, C., Tapia, E., Svoronos, S. A., Phlips, E., Ruiz-Filippi, G., Pullammanappallil, P.C, University of South Florida

Marine microalgae could potentially serve as sustainable feedstock for biogas production in an anaerobic digester. However, high salt concentration in the microalgae biomass, may inhibit the growth and activity of anaerobic digester microorganisms. Conventional anaerobic digesters will have to be acclimatized to high salt containing feedstocks. In this paper the changes in the microbial community structure and performance of mesophilic (38^{o}C) and thermophilic (55^{o}C) digesters while being acclimatized is presented. Two 5 liter anaerobic digesters (4 liter operating volume) were used. These were modified Pyrex glass bottles and placed inside temperature controlled chambers and agitated using a magnetic stirrer. Inoculum for mesophilic digester was 4 liters of mixed liquor from a pilot scale digester treating flushed dairy manure and inoculum for thermophilic digester was leachate from a leach-bed digester treating organic fraction of municipal waste. The operational protocol involved feeding both digesters with black-strap molasses, and increasing sodium chloride content gradually. Initially 0.5g of molasses along with other nutrients and sodium chloride dissolved in 100 ml of DI water was fed after withdrawing 100 ml of digester mixed liquor. The feeding process was stopped when methane production ceased and restarted it when methane production picked up. Molasses amount was then increased stepwise to 2g, 3g, 4g and 5g, and the digesters were operated at each level for a few days. The digesters were operated for over 300 days. Microbial community was analyzed to monitor changes in the microorganisms. pH, salinity, and total volatile fatty acids (VFA) were monitored. Biogas vented from digesters was scrubbed to remove CO_2 by passing the gas through soda lime. The scrubbed gas was metered using a positive displacement gas meter. Results showed that the acclimation to salinity is an inhibition-and-recovery process. For the mesophilic digester, from an initial salinity of 1.28% as it was increased gradually, methane production rate fluctuated and pH gradually decreased from 6.9 to 6.65. When salinity reached 3%, the methane production ceased and feed to digester was stopped. Total VFA ranged between 5.48 - 15.65 mM. After period of 40 days methane production picked up, feeding was continued but only 50ml of feed was added. Similar trends were observed in the thermophilic digester. Starting the operation with the salinity of 0.63% resulted in a complete cessation of methane production at salinity of 2.3%, but picked up after 60 days. pH varied between 6.5 - 7.2. After a prolonged period time, microbial community in anaerobic digesters can be adapted successfully to at salinity levels of 36 - 38 NaCl g/L and methane production was sustained. The mesophilic digester has been operating at a salinity of 3.8% for over 75 days with a yield of methane of 170 ml/g molasses, which is about 72.65% of the theoretical yield. The thermophilic digester has been operating at a salinity of 3.6% for over 45 days with a yield of about 192 ml methane/g molasses, which is about 81.2% the theoretical yield.

Novel Biocatalylic Process for Biodiesel Production - <u>Huali Wang</u>, Brent Chrabas, Viesel Fuel LLC.

We have conducted work that demonstrates the proposed continuous biocatalytic process efficiently converts low quality biomass into alkyl esters of fatty acids. A continuous stirred-tank reactors (CSTRs)-in-series reaction system has been successfully commercialized by Viesel Fuel LLC to produce biodiesel from low quality feedstocks. It is the most efficient and economical process of biodiesel production requiring only moderate temperatures and pressures and producing a 99% conversion yield with low grade feedstocks, such as waste cooking oil, animal fats, brown grease, FOG, etc.

Track II: Solar Energy

An Analysis between the State of Solar Energy Development in Europe and the United States - Mary Kate Fitzgerald, Gage Vincent, Estelle Wilson, Pan Xu, Nicholas Yonezawa, Fazil T. Najafi, University of Florida

Development of concentrated solar farms is becoming more common in the United States. Several states are taking the lead in solar energy production, and many other states are not far behind. With many European countries setting an industry-leading standard, a detailed comparison between the United States' developing renewable energy initiative and Europe's long-established energy action plan illustrate areas where the United States can further succeed in investing in renewable energy. An analysis of global horizontal irradiation maps suggests that, geographically, the United States' solar energy production could exceed solar energy production in Europe. Even with lower average solar radiation when compared to the US, the European Union has been tremendously successful at developing solar energy technologies, primarily through their innovative financing and Feed in Tariff strategies and through community buy-in. Therefore, development of American solar facilities is critical to the United States' renewable energy portfolio. Rapid development of solar technologies and attractive government incentives have contributed to the growth of concentrated solar fields in both Europe and the United States. There are numerous benefits of solar energy production. In addition to the obvious carbon reduction benefits, construction of solar fields also increases job opportunities and helps diversify the local economic portfolio. There are a few negative issues associated with solar field development, including land use compatibility issues, environmental impacts and aesthetic impacts to a community. However, learning from and improving upon Europe's successes in renewable energy, more American policy and guidance documents are being developed to assist in proper design and development of solar facilities across the country. Through proper policy and design, the United States can utilize concentrated solar energy development to increase its renewable energy portfolio and diversify its energy supply.

Advancing Solar – Susan Glickman, Southern Alliance for Clean Energy

Join us! Sign the petition TODAY! Visit www.FLsolarchoice.org to learn more about the benefits of customer solar energy options. Sign up for free updates and help spread the word. Together we can remove unfair state policies that block competition and encourage monopoly control of our energy choices. We can join other states and open the door to a truly free market that allows competition, choice and energy freedom.

The Integration of Solar Power as a Renewable Source of Energy in the United States - Patricia Cruz, Doug Hinton, Dorian Johnson, Cara Keller, Giuseppe Zuozo, Fazil T. Najafi, University of Florida

As of 2005, the United States government has created many initiatives to reduce Carbon Dioxide (CO_2) emissions by 17% by 2020. As of 2014, CO_2 emissions have been reduced by 10.7%. It can be concluded that the most viable way to decrease these emissions, the remaining 6.3%, is through the introduction of more renewable energy sources. Solar power has great potential to aid in this reduction, but only if it is implemented on a larger scale, as solar energy only accounts for 0.3% of the energy consumed in the United States. To explore the feasibility of this expansion, it is important to understand how solar electricity can be generated in rural and urban environments, as well as the benefits and disadvantages to large-scale operations. It has been concluded that the amount of rural land required to provide the entire United States with power is equivalent to approximately 13.4 million acres. If the capital investments could be made, large solar farms could be a feasible option for providing power in the United

States, particularly to the southwestern section of the country. The southwest region of the U.S. is a region of high solar radiation levels, make it an ideal area for placing solar energy system. The U.S. Department of Interior's Bureau of Land Management currently manages 19.3 million acres of public land in the southwest states of California, Nevada, Arizona, New Mexico, Colorado, and Utah. The Bureau has assessed the land and determined the best locations suited for utility—scale production of solar energy, they have come to define these locations as solar zones and there are 19 of these solar zones. If the 19 designated solar energy zones are to be fully built out as planned, the designated areas could produce as much as 27,000 megawatts of solar energy. This is enough energy to power approximately 8 million homes. Solar power has already been integrated into some urban areas of the country, namely, San Diego, California. It has been determined that the installation of solar panels atop of houses, buildings, and parking garages would easily suffice San Diego's energy needs. By following this model for other larger cities it is possible to similarly reduce the use of fossil fueled power production in urban areas. Local governments are also key factor in establishing policies that promote small-scale solar power production in these urban areas. It is feasible that large solar farms in rural locations and small-scale urban installation may lead to more innovative applications for solar power and help United States reach their emissions goals.

Conducting Polymer-Dye Composites for Photoelectrochemical Solar Cells and Energy Storage - Arash Takshi, University of South Florida

Given the sustainable, clean, and abundant nature of solar energy, studies on photovoltaic devices for energy conversion to electric energy have been extensive. However, due to large variation of the solar energy availability in a day, energy storage is required in many applications when solar cells are used. Conventionally, the harvested energy is stored in an external device (i.e. batteries or supercapacitors) which adds substantially to the costs of solar energy systems, requires additional charging circuitry, and needs regular maintenance and replacement. The result is a relatively expensive and bulky system that is not ideal, particularly for portable, off-grid applications. Recently, we have found that a combination of a conducting polymer (PEDOT:PSS) and a porphyrin based dye molecule can be used as an electrode in a photoelectrochemical cell to generate electric charge from solar energy and store the charge in the device. The structure of the device is very similar to a supercapacitor, while the conducting polymer-dye composite film behaves likes a photoactive electrode. The device is able to generate up to 0.49 V under the open circuit conditions upon AM1.0 solar radiation. A charge stability (in dark) of more than 2 hrs has been achieved after charging the device with light for 20 min. The organic photoactive supercapacitor can deliver currents up to 0.12 mA/cm2. The electrochemical study suggests a photoelectrochemical reaction at the composite film. Hence, the charge storage is likely due to the change in the polymer oxidation state.

Atmospheric Pressure Chemical Vapor Deposition of Functional Oxide Materials for Crystalline Silicon Solar Cells - Kristopher O. Davis and Winston V. Schoenfeld, University of Central Florida-FSEC

Atmospheric pressure chemical vapor deposition (APCVD) is a versatile manufacturing process that offers much promise in enabling significant efficiency gains and cost reductions for crystalline silicon (c-Si) solar cells. In this presentation, recent results on the deposition and subsequent processing of functional oxide films using an in-line, high throughput APCVD system will be reported. The materials deposited in this work include aluminum oxide, titanium oxide, silicon oxide, and doped silicon oxide. These oxide films and film stacks can be utilized for doping (e.g., emitter and surface field formation), surface passivation, and photon management on the front and rear side of c-Si solar cells. Experimental data regarding the microstructure, optical properties, and electronic properties of the films will be presented, along with the impact of these films on cell efficiency and other relevant cell parameters. Implications of these results for standard and novel c-Si cell architectures will be covered.

Establishing Field Equivalents of Accelerated Tests for Bypass Diodes in PV Modules - ***Narendra Shiradkar, Vivek Gade, Kalpathy Sundaram, Winston Schoenfeld, University of Central Florida-FSEC***

Levelized cost of energy (LCOE) of a PV project is calculated as the total project cost divided by the total energy produced during the project lifetime. LCOE of PV technology needs to be reduced significantly in order to make solar energy cost competitive with other energy sources without the need for any subsidies. Reliability of PV modules affects the degradation rate, project lifetime and the uncertainty in the energy production (discount rate). Accelerated tests are typically used to assess the durability of PV modules and components. Only when precise acceleration factors are available, module/component performance in accelerated tests can be used to predict the lifetime in field.

Bypass diodes are primary components in PV modules that provide protection against shading. Whenever a PV module is partially shaded, the diode corresponding to the shaded sub-string of cells is forward biased and its temperature begins to increase. If the shading is held constant, the diode eventually reaches a state of thermal equilibrium. The maximum diode temperature is determined by the ambient temperature and the diode current. These parameters in turn depend on the module mounting configuration, geographical location, solar irradiance, shading configuration and the load connected across the module. Bypass diodes used in PV modules are expected to endure much harsher conditions for much longer duration than their counterparts used in consumer electronics. The extended bypass diode test in Qualification Plus standard developed by NREL involves passing current equal to short circuit current (Isc) of PV module through the diode for 96 hours, at 75 C ambient temperature followed by 1 hour at 1.25 x Isc current. The goal of present study is to determine field equivalent of the extended bypass diode test in three representative climatic zones- hot-dry, hot-humid and temperate and two module mounting scenarios – roof mount and rack mount.

Thermal resistance of various junction boxes is experimentally measured at various diode temperatures. Outdoor data about diode temperature is used to validate the one-dimensional thermal conduction model for predicting diode temperature from the Typical Meteorological Data (TMY) and the properties of the diode / junction box. Hourly diode temperature distributions at three locations for the typical year are calculated. Arrhenius relationship and activation energies provided by JEDEC are used to determine the acceleration factors and field equivalents of the extended bypass diode test.

Factors in the Formation of Cracks in Mono-Crystalline Silicon Solar Cells - ***Hubert Seigneur, Narendra Shiradkar, University of Central Florida***

Cracks in solar cells can lead to a reduction in the module power output instantaneously or over time. They are also known to play a role in other reliability/safety issues such as optical blemishes, hot spots, and arcing. As a result, there is much interest in being able to prevent the formation of crack during cell and module manufacturing and subsequently in the field. This work seek to understand critical factors in the formation and the propagation of cracks in monocrystalline silicon solar cells. More specifically, we have investigated the relationship between residual stress within the silicon substrate and the formation of crack as well as the effect of potential crack initiation sites in the form of laser scribing.

Nanoscale Interfaces in Energy Applications - Luping Li, Cheng Xu, Kirk J. Ziegler, University of Florida

Nanostructures are becoming key aspects of numerous next-generation energy devices, including photovoltaics, thermoelectrics, ultracapacitors, batteries, and piezo electrics. However, fabricating and integrating these structures into devices requires control over multiple interfaces. Many of these devices also require substrates with specific properties of flexibility, transparency, and lightweight. These issues are more problematic in the fabrication of arrays of vertical nanowires. For most energy applications, ultra-high surface area nanowire arrays are necessary to maximize device efficiencies beyond their current limits. Thus, the key challenge lying ahead is not only to improve methods to maximize the surface area of these nanostructures but also to fabricate them onto desired substrates with optimized interfacial properties. Our group focuses on developing novel fabrication processes for ultra-high density nanostructured surfaces that allow control of interfacial charge transfer and bulk charge transport. These nanostructures are then integrated into photovoltaics, thermoelectrics, and ultracapacitors. In this presentation, we will focus on improving electron recombination in dye-sensitized solar cells (DSSCs) based on vertical nanowire arrays.

Recent Advances in Polymer Solar Cells – Ifedayo Ogundana, Simon Y. Foo, Zhibin Yu, Indranil Bhattacharya, FAMU – FSU College of Engineering

There have been significant achievements in polymer solar cells (PSC) in the last five years, notably a significant increase in power conversion efficiency (PCE) with the addition of the perovskite absorber layer and formation of inverted PSC. Recently, a team from Korea was able to achieve a PCE of about 18% by blending methylammonium lead bromide with formamidinium lead iodide through an 85:15 mixture. Several methods have been proposed by different researchers to improve the PCE of PSC over the years. Some of these methods include addition of functional groups and monomers, addition of optical spacer, modification of printing and processing techniques, addition of absorber layer material, and development of new active layer material. Current challenges in perovskite-based PSCs include improving efficiency by understanding the material properties and optimal cell designs, replacing toxic Pb with non-toxic element, long-term stability, and higher efficiency through structural modification and band gap tuning.

Smart Solar Electric Vehicle Technology - Ashly Locke, Ryan Integlia, Sesha Srinivasan, Jorge Vergas, Jaspreet Dhau, James Mulharan, Eric Vickers, Florida Polytechnic University

The purpose of this project is to support educational research in Smart Solar Electric Vehicle Technology and practical applications, help advance educational initiatives, the technology with local corporations, and to develop team building concepts. The project will explore the application of advanced materials, processes, structural properties and functionality. A critical component of this effort will explore autonomous vehicle innovation to address the emerging issues around smart vehicle infrastructure. The Smart Solar Electric Vehicle Technology will be integrated into the existing development effort for the course "Renewable Energy Systems and Sustainability" (EEL 3287) and student projects.

Performance Analysis of C-Si Module Deployed at FSEC after 10 Years Exposure - Eric Schneller, Joe Walters, Stephen Barkaszi, Kris Davis, Winston Schoenfeld, University of Central Florida

An 8.25 kW rooftop system installed in a hot and humid climate was baselined and tracked for a decade. The system consisting of over 150 solar modules was installed at the Florida Solar Energy Center (FSEC) in 2004. At the time of installation the modules were typical of the high quality modules commercially available. Prior to installation, the performance for each module was measured using an indoor solar simulator to obtain I-V measurements at standard test conditions. At the conclusion of the decade a subset of these 55W mono-crystalline solar modules were inspected and characterized. Electrical performance data of the modules was collected both before and after cleaning to understand influences of dirt accumulation. Additionally, module leads/connectors were tested for resistive losses. Defect detection was carried out using electroluminescence imaging to provide insight into the degradation mechanisms leading to performance loss. The objective of this work is to provide valuable statistical information regarding the long-term reliability and degradation rate of c-Si modules in the hot and humid climate of Florida.

Solar Thermochemical Fuel Production at the University of Florida - Jonathan R. Scheffe, David W. Hahn, Renwei Mei, University of Florida

Solar Energy Research at the University of Florida is focused on innovative approaches to energy conversion processes, primarily through solar thermochemical pathways. This involves research ranging from the discovery of redox active metal oxides (e.g. perovskites, doped ceria), the characterization of their thermodynamic and kinetic properties, and finally to the development of application scale technologies such as solar thermochemical reactors, solid oxide fuel cells, and oxygen separation membranes. Research is primarily conducted in two locations: 1) at the High Flux Solar Simulator (HFSS) Laboratory located at UF's Solar Energy Park and 2) at the Solar Thermochemical Energy Conversion (STEC) Laboratory located on the main campus in the MAE building.

The HFSS is one of three located at academic institutions in the United States and is specifically designed to test high temperature thermal receivers and thermochemical reactors under realistic conditions. It is capable of delivering up to 10 kW of high flux radiation (5000 suns peak) using Xe-arc lamps with a photo-spectrum similar to sunlight. The simulator laboratory is fully equipped with data acquisition and control hardware (temperature, mass flow rates, pressure) residual gas analysis (mass spectroscopy and NDIR) and is fully compatible with a range of reactor geometries and sizes. Beyond testing concentrated solar power receivers and solar thermochemical reactors, this device is well suited for testing materials and/or engineered structures for a range of high temperature applications.

The STEC Conversion Laboratory is equipped with a high temperature (up to 1600 °C) thermogravimetric and differential thermal analyzer (TGA and DTA) to characterize fundamental thermodynamic and kinetic data of solid oxides and heterogeneous reactions. Furthermore, it is equipped with an automated thermal cycling furnace designed to subject samples to multiple cycles at high temperatures with a range of reactive conditions to study the effect of cycling on their chemical, morphological and mechanical behavior. The laboratory is well suited for chemical synthesis and serves as a fundamental counterpart to more applied scaled-up reactor development and device testing at the HFSS laboratory.

High Efficiency Thermochemical Fuel Production Using the UF 10 kW Solar Reactor - Kelvin Randhir, Like Li, Nick AuYeung, Amey Barde, Benjamin Greek, Nathan Rhodes, Renwei Mei, David Hahn, James Klausner, University of Florida

The synthesis of chemical fuels from sunlight is a research area that has attracted significant attention in recent years due to the potential of providing a fully sustainable pathway for transportation. Due to the high energy density and the existing global infrastructure for fuel transport and handling, the storage of solar energy as a fuel is a superior concept. The high temperature solar thermochemical approach uses water and recycled CO_2 as the sole feed-stock and concentrated solar radiation as the sole energy source. Thus, the solar fuel is completely renewable and carbon neutral. Though very attractive, economically viability (with conversion efficiency greater than 20%) will require well-designed energy conversion devices to maximize the overall conversion efficiency. The current world record efficiency is less than 2%. The University of Florida (UF) Solar Fuels Team has designed, fabricated a 10 kWth prototype solar reactor for H_2 and CO production from H_2O and CO_2 splitting via redox cycling of cerium oxide. It consists of a horizontal cylindrical cavity that absorbs the concentrated solar power from the UF High Flux Solar Simulator (HFSS) through a windowless aperture, and an array of 14 cylindrical tubular absorbers arranged at the circumference of the cavity. Reactive materials are loaded in the tubes and indirectly heated by the concentrated solar power. Using a vacuum pump to enhance the thermal reduction, and applying the scheme of simplified axial flow during oxidation, experimental demonstration for more than 50 redox cycles have been conducted. The 11-tube experimental data (almost full capacity of 14-tube) over 6 consecutive redox cycles showed conversion efficiencies greater than 5% without optimization of operation conditions. The Team has been optimizing the operational conditions to maximize the conversion efficiency.

The Costs and Benefits of Solar Road Technology - Courtnay Cardozo, Juan Camargo, Kyle Findlater, Josh Herrera, Fazil T. Najafi, University of Florida

Solar road technologies are a big part of our future and important in the pursuit of powering the world's infrastructure with clean, carbon emission free energy. This paper will explain how the technology works, the associated cost of its implementation and the benefits as well as the detriments to its commercial availability and use. The end result is to have all concrete and asphalt surfaces with exposure to the sun be covered with Solar Road Panels. Many asphalt pavement issues will be eliminated with solar panel roads, including iced over roads, potholes, lengthy maintenance, and repair. With these problems gone, cost from traffic congestion will decrease and safety will increase.

Vehicle safety during wet conditions is just as adequate as asphalt pavement and will also improve night driving safety with LED lighting. Implementation will be a lengthy process, but the enormous benefits solar roads offer are unmatched and vital to our nation's future growth. These benefits that are provided by solar roadways sometimes come at a price. Taxes being the main form of payment for any roadway and those same taxes will have to rise in order to compensate for the rise in technology. However, it can be seen that with the amount of energy that can be collected and distributed, it works out in the long run. Solar roadways can be used for multiple utilities merging them to one energy source (Cable TV, Internet, Telephone, etc.).

Thinking about the issues natural fossil fuels bring to this planet, using solar roadways to capture a natural form of energy allows us to stray away from the limited supply of fuel left, and allows us to keep our planet safe from the harmful effects those fuels have. When all is said and done, the cost of new technology is well worth the advancement these roadways provide us. While there are small-scale applications of this technology in existence, having it become a widely-accepted way of building infrastructure will take a great amount of time and effort. However, the research showed that the benefits of applying this technology to new and existing infrastructure greatly outweigh the costs and can become a primary and widely-applicable renewable energy technology in the future.

Thursday, May 21- 10:15 am - 11:25 am
SESSION III ENERGY EFFICIENCY AND SMART GRID/ENERGY STORAGE ORAL PRESENTATIONS

Track I: Energy Efficiency

Boosting Efficiency in Buildings - Chris Castro, Jonathan Ippel, City of Orlando

In every major American city, buildings account for the majority of energy use and carbon pollution–even more than the transportation or industrial sectors. If cities want to be more competitive and more resilient against energy-related crises, they must boost the energy efficiency of their building stock.

In the City of Orlando, 6% of the number of buildings contribute to 57% of the impacts regarding energy use and carbon pollutions, showing the improving the energy performance of these buildings will yield significant, rapid results to reaching our energy and climate action goals. However, in order to achieve significant energy savings, cities must know how much energy their large buildings are using in the first place.

As a participant of the City Energy Project, the City of Orlando is developing a framework of policies and programs that will increase energy efficiency investments in commercial, multifamily, and industrial real estate sectors. This multi-faceted approach will work on improving the city's municipal building portfolio, enabling actionable information about energy use, creating new financial instruments, developing custom incentive programs for improve performance, crafting new workforce development programs that educate building operators, exploring new energy codes and green building standards (for new construction), and launching creative ways to spur investments through competitions.

This presentation will unveil the overview of City Energy Project initiatives, and disclose what the City of Orlando is working on to become a national leader in energy efficiency for new and existing buildings, as part of Mayor Dyer's Green Works sustainability program.

High Efficiency Multi-Family Housing Renovations at UF's Corry Village - Craig Miller, Bahar Armaghani, Steve Wargo, University of Florida Program for Resource Efficient Communities

The Department of Housing and Residence Education at the University of Florida maintains 33 administrative buildings encompassing 180,264 square feet, 44 residence halls encompassing 1,829,459 square feet of space housing 7,568 single students, and 87 buildings in Graduate and Family Housing encompassing 842,120 square feet of space housing 1,900 residents in 980 apartments. The overall average age of all facilities is 52.8 years. Corry Village, comprised of 100 single bedroom and 116 two bedroom apartments in 13 separate buildings, opened in 1959.

In addition to meeting the Green Building Goals outlined in the University of Florida's Housing & Residence Education 2012-2018 Master Plan, building remodeling will meet/exceed all "green building" strategies for the Unites States Green Building Coalition (USGBC) Leadership in Energy and Environmental Design (LEED) certification program. The ultimate goal is to reduce energy and water consumption of dwelling units through best designs, materials, product selections, and tenant education.

Efficiency of Florida's Affordable Multifamily Housing: Diving Deeper into Consumption, Property, and Tenant Characteristics Data - ***Nicholas Taylor, Jennison Searcy, Anne Ray, Lesly Jerome, University of Florida Program for Resource Efficient Communities***

Florida has one of the largest shares of multifamily housing units nationwide. Of the state's approximately one million low-income renters, nearly one-quarter (~238,000) live in assisted and public housing units. At the same time, analyses of trends in Florida's housing cost data (rent plus utilities) and tenant incomes conclude that increasing numbers of low-income renter households face moderate to severe housing cost burdens. This poster and presentation describes preliminary results of a data-driven, three-year multifamily research project supported by the John D. and Catherine T. MacArthur Foundation under the umbrella of their "How Housing Matters" initiative. The study is a collaborative effort being led by faculty with the University of Florida's Shimberg Center for Housing Studies and Program for Resource Efficient Communities. The ultimate study goal is to help identify effective pathways to alleviate housing cost burdens being borne by those who can least afford them: low-income renters.

One phase of the research is to characterize the energy efficiency of the Florida Housing Finance Corporation's (FHFC) portfolio of subsidized, multifamily residential developments. To do so, we rely on a database that matches monthly property, unit and tenant household data from FHFC's Tenant Data Reporting System with energy billing data from three municipal utility companies. Our FHFC housing sample includes over 100 multifamily properties (~14,500 units) in Gainesville, Jacksonville and Orlando. The analysis is divided into two parts. The first explores the variation in median energy consumption by unit and household characteristics, including number of bedrooms, household size and composition, funding year, tenant income, and the presence and types of federal rental assistance. The second describes variation in energy use across the whole portfolio and within individual properties, with a focus on "top tier" users with high energy consumption and costs.

Median annual electric use for units in the three territories ranges from 7,400 to 8,700 kWh ($890-1,044/yr). This level of consumption is slightly lower than the U.S. DOE's estimated average electricity consumption for multifamily rental units in the South Region (9,202 kWh/yr), and considerably lower than the total average multifamily energy use for all fuels (12,162 kWh/yr). Preliminary analysis results are consistent with expectations: units with more bedrooms, larger households, and families with children have higher median consumption levels, while smaller units and households and elderly tenants tend to consume less. However, extremely low-income tenants do not use less energy than tenants with more moderate incomes, placing them at risk for a high energy-cost burden if utility allowances are not adequate.

High consuming units are spread throughout the portfolio rather than concentrated in a few poorly performing complexes, so efficiency initiatives that target the high consumption units across several properties may be more effective than a few whole-property retrofits. To design effective initiatives, we first must identify the role of tenant behavior and household characteristics versus physical unit factors in generating high electric use. Future research will include a more detailed analysis of interactions between building features, occupant demographics, and behavior over time.

Multifamily Energy-Efficiency Retrofit Programs: A Florida Case Study - Nicholas Taylor, Jennison Searcy, Pierce Jones, University of Florida

Multifamily buildings are an important target for efficiency improvements because of their energy savings potential and housing market share. Yet few multifamily retrofit projects have been completed in hot-humid regions and even fewer studies have measured and verified savings from such projects. Addressing this gap, the purpose of our research is to assess the impacts of energy-efficiency upgrades to multifamily buildings in Orlando, Florida. Specifically, we measure the first-year electricity savings from retrofits to 232 units in four apartment complexes. Annual savings per unit averaged 2,094 kWh (22%) and ranged from 1,700 kWh (18%) to 3,811 kWh (29%) across complexes. Monthly savings ranged from 48 kWh (9.4%) in December to 340 kWh (31%) in August. From these core findings, we estimate that tenants in treatment units saved an average of $272 on their electric bills. We also find evidence to support a strategy of targeting upgrades to improve overall savings and program cost effectiveness. Results are being used to guide development of a utility demand-side management program for multifamily property owners. Progress in this market requires additional pilot projects, access to utility data, reliable measurement and verification of savings, and innovative financing structures.

Design of Incentive Programs to Promote Net Zero Energy Buildings - Alireza Ghalebani, Tapas K Das, University of South Florida

Promoting net zero energy buildings (NZEB) is among key carbon emissions reduction approaches that have been widely adopted by policy makers in recent years in the U.S. and in the EU countries. However, since generation of electricity from renewable energy (RE) sources, for buildings to achieve net zero status, is still relatively expensive, federal, state, and local governments offer various incentive programs. The task of determining the minimum thresholds of these incentives that would spur growth in NZEBs is a difficult one, as the threshold for each incentive is likely to be influenced by building type, RE technology, desired return on investment, weather, and the levels of other incentives. This paper presents a mixed integer programming (MIP) model to aid in the above task. The model is particularized for wind and solar energy sources. The incentive programs considered in the model are low interest loans, rebates, performance based incentives, tax credits, and net metering. A time-of-use (TOU) pricing structure for electricity is assumed to be in effect.

The MIP model minimizes the annual cost of energy. Model implementation is demonstrated using buildings in two cities in the U.S. with different climate conditions (Long Island, NY and Tampa, FL) and each with three different load profiles. The results indicate the threshold values of the incentive program parameters, and show that these thresholds are highly influenced by the levelized cost of electricity from RE and are independent of load profiles.

Experimental Exergy Analysis of an Off-Grid Zero Emissions Building - Sam Yang, M. Chagas, J.C. Ordonez, J.V.C. Vargas, C. Ordonez, Florida State University

Experimental exergy analysis of an Off-Grid Zero Emissions Building (OGZEB) at the Florida State University Energy and Sustainability Center has been conducted in efforts to identify HVAC components with high entropy generation rate (i.e., exergy destruction rate). Among the components that constitute the HVAC system of the OGZEB, this study assess the exergy flow in the solar thermal collector and thermal energy storage unit. In addition, an exergy analysis of the geothermal loop coupled to the HVAC system is performed to compute its exergy destruction rate for possible geometric and parametric optimization. Temperatures, solar irradiance, and mass flow rate are measured on different days (i.e., different ambient conditions) and used to compute the exergy flow and destruction in the OGZEB. This work serves as an initial step to the integrative thermodynamic optimization of the HVAC system in an off-grid residential building where most energy is required for heating and cooling.

Optimization of Chilled Water Plant Operation using Modelica Buildings Library - Sen Huang, Wangda Zuo, University of Miami

Chilled water plants consume significant amount of energy. In order to improve the chiller plant energy efficiency, we propose a framework to continuously optimize the parameters of the supervisor control system of the chilled water plants according to the predicted weather condition and cooling load. The framework results in a platform that allows the seamless integration of a physics-based model of the chiller plant and a rapid optimization tool. We model the physical and control systems using Modelica Buildings library and perform the optimization using the GenOpt optimization package. The entire optimization process, including data pre-processing and post-processing, is automated via a suite of Python functions that we have developed. To demonstrate the usage of this platform, we optimized the chiller condenser water set point and performed an offline simulation to evaluate the energy saving of proposed optimization strategy. Partnered with the Lawrence Berkeley National Laboratory, our tool is currently being installed and evaluated at the US Naval Academy.

Transportation Energy and Space Technology Hub (TEST Hub) at NASA Kennedy Space Center – Advanced Transit Technology Demonstration Projects: Dual-Fuel Fuel Cell Demonstration and Thermo Electric Generation Transit Bus Demonstration - David Teek, Tim Franta, Mike Aller, Energy Florida

The presentation and poster will outline two innovative energy technology demonstration projects being conducted at the Transportation, Energy and Space Technology Hub (TEST Hub) established by Energy Florida and its partners at the NASA John F. Kennedy Space Center (KSC). The TEST Hub provides an interface and services that enables companies, universities and agencies to utilize KSC facilities and expertise for energy related research, development, demonstration and test activities. Energy Florida, KSC and International Trade Bridge (ITB) have coordinated with the Department of Energy to secure hydrogen and fuel cell assets, including a $2 million Proterra 2.0 fuel cell bus, a hydrogen vehicle fueling system, and a set of stationary fuel cell power units as the foundation of a new dedicated advanced transportation and fuel cell development and commercialization capability.

The Advanced Transportation Dual-Fuel Fuel Cell Development and Demonstration project will conduct pre-commercialization development, demonstration and test activities on Bing Energy's prototype Modular Dual-Fuel (Hydrogen/Oxygen) Auxiliary Power Unit Range Extender. This system provides ultra-high power density by using Bing's buckypaper technology (originally developed at Florida State University) and hydrogen/oxygen fuel sources. The commercial product will be EnerFuel2, a modular fuel cell unit designed for use in zero emission fleet vehicles, enabling all-day operations without refueling or charging. The project will validate the performance of the Bing EnerFuel2 fuel cell system and help address unique issues associated with having both oxygen and hydrogen feeds.

The project is being funded through an award by Space Florida that is being matched by the Florida Office of Energy within the Department of Agriculture and Consumer Services (DACS), under the new Renewable Energy and Energy-efficient Technologies (REET) grant match program.

The Thermo-Electric Generation (TEG) Transit Bus Demonstration project will develop, install and demonstrate the effectiveness and efficiency of a thermoelectric generator in providing power for accessories of a diesel-powered transit bus, reducing the amount of power required from the alternator during operations. The Federal Transit Administration has provided funding to the Center for

Transportation and the Environment (CTE), and a consortium of partners including Hi-Z, Energy Florida, ITB, Florida Solar Energy Center (FSEC), and LYNX Transit with the goal of developing, testing and demonstrating a thermoelectric generator installed on a transit bus from LYNX's fleet in Orlando.

Thermoelectric heat waste will be used to reduce the amount of fuel needed to operate the transit bus while in service. The project will apply this technology initially developed for spacecraft and transition this work to transit systems with a waste heat recovery system that is expected to generate 1000W of 24V power to support bus systems, utilizing energy that will otherwise literally be sent out the tail pipe.

Earlier versions of the proposed system have been demonstrated on automotive, military vehicle and diesel truck uses in work funded by the Department of Energy, National Science Foundation and the Department of Defense. This technology can now provide a new way to reduce transit engine demand and achieve reductions in fuel consumption and emissions.

Ducted Heat Pump Water Heater Cooling and Heating Performance in Florida - Carlos J. Colon, Eric Martin, Danny Parker, University of Central Florida - FSEC

The Building America Partnership for Improved Residential Construction (BA-PIRC) investigated the effects of ducted heat pump water heaters (HPWH) on space conditioning energy use and water heating at the Florida Solar Energy Center (FSEC), Cocoa, FL. To assess HPWH ducted ventilation strategies and impact on air conditioning under a hot-humid climate, FSEC conducted controlled experiments in two geometrically-identical, full-scale, side-by-side residential research facilities known as the flexible residential test facility (FRTF). The only difference between these two facilities during the HPWH experiment was the floor material used – carpet and bare concrete floors. Comparisons were made between three modes of airflow in each unit –rotating every ten days: Air supplied and returned from the conditioned home; air supplied from the outside via the HPWH to the home; and a supply and return from the garage which helps serve as a base case. The HPWH's utilized adapter kits, eight-inch (8") ducts and manual dampers to divert the airflow between the interior, outside and garage airflow paths. Ducting a HPWH led to reduced airflow rates (148-160 cfm) compared to the most common unducted configuration of 450 cfm, as claimed by the manufacturer. Automated hot water consumption was altered monthly and ranged between 34 and 57 gallons per day. On average these two homes measured 20 kWh/day of energy consumption on their primary HVAC equipment (3-Ton, SEER 13, 77 F thermostat setting) during the cooling season without HPWH ventilation. Savings of 2.0 kWh/day or 10% reduction, were achieved by using the interior (balanced) HPWH airflow path configuration during cooling season. However, when using an outdoor to interior (pressurized building) airflow path configuration a 2% (+0.375 kWh/day) penalty on the primary HVAC system was incurred. Heating season in central Florida is not as severe as in other parts of the country. The buildings utilized 4.8 kWh/day on average baseline during the heating season (Dec-Feb) with thermostat setting of 73 F. On average, a 1 kWh per day of additional energy consumption was recorded during the heating season when using interior to interior airflow path configuration. When the dampers were set to introduce outside air into the interior space, 3.6 kWh per day of additional space heating was incurred. Run time of the HPWH was also investigated as it could benefit ventilation of homes (ASHRAE 62.2) using the aforementioned ducted strategy. Heat pump water heater runtime is a function of hot water use, inlet water temperatures (Higher winter runtimes) and thermostat setting. The outside to interior ventilation of 148 cfm provided by the HPWH could lead to 33% of ventilation requirements of a new 1,535 square foot home having and infiltration rate of 8.0 air changes per hour (ACH) at 50 pascals. If the same home would have a tighter envelope having a measured 5.0 ACH50 it would only contribute about 23.5%.

Greenstar Roof Insulation: Heat Evicting Innovation – Paul White, Greenstar Panels

Greenstar Panels is a product developed to combat Florida's unique climate with high humidity and over 300 sunny days each year. All of our product is manufactured in Lakeland and 100% of our installations have been completed in the Florida. We are truly a homegrown enterprise that has developed solutions for our hot garages and stifling hot attics. Hyper-Insulation is the best way to describe Greenstar Panels as it is designed to challenge all 3 types of heat transfer, Radiant, Convective and Conductive heat.

Architectural Testing in Fresno, CA conducted Solar Calorimeter tests comparing the SHGC of Greenstar Panels to R-30 fiberglass insulation in June 2013. The Test method used: NFRC 201-2010, "Interim Standard Test Method for Measuring the Solar Heat Gain Coefficient of Fenestration Systems Using Calorimetry Hot Box Methods". The results showed that GPS 1.5" and R-30 fiberglass were virtually equal in performance while the GSP 2.0" out-performed the R-30 fiberglass by over 26%.

After 200 plus installations in existing homes the results have consistently shown that Greenstar Panels will reduce attic temps as much as 80 degrees maintaining temps under 100 degrees on our hottest summer days. Customers have experienced reduced electric consumption ranging from 15-50% for full year comparisons of before and after installation. It would be incorrect to state that Hyper-Insulation is the only product that can keep the heat out of an attic space.

Spray foam has gained popularity the last 20 years because it protects the entire structural envelope from outside elements too. However, there have been widespread unintended consequences associated with SPF. First, SPF has put occupants' health at risk with off gassing because of improper mixing and application. Secondly, when a roof develops a leak it could go undetected until an entire roof deck is compromised.

Hyper-Insulation is truly a Green product. EPS is food grade insulation, safe as a coffee cup. EPS last forever, never needs servicing and can be recycled. By design, it vents away heat and actually cools a roof surface compared to a traditional attic.

Planning for Urban Sustainability: Comparing the Impacts of Residential Design Alternatives - Lynn M. Jarrett, Hal S. Knowles III, Barbra C. Larson, University of Florida Program for Research of Efficient Communities

Objectives: Choices made during the planning stages of residential development affect ecologic, social, and economic aspects of our families and communities. The location, density, and layout of a new community builds in resource demands and environmental impacts that will affect our daily lives. For instance homes on large lots with in-ground irrigation systems build in a higher level of energy and water consumption than do homes in multi-family and mixed use communities. Long-term impacts on all aspects of the natural environment – from air and water quality, future water availability and preservation of natural ecosystems are also affected by development choices. Because these impacts of development decisions are not immediately apparent, a tool that can help developers or city planners quantify and compare these impacts at the early planning stage could lead to more sustainable development decisions.

Methods: A methodology for evaluating development alternatives and quantifying the relative differences in energy and water consumption, greenhouse gases (GHG), infrastructure costs and other parameters due to residential density and community structure was demonstrated in a comparative case study of three development scenarios. Resource consumption was calculated per household type and density based on local measured utility data and modeled the impacts of three land use scenarios, for 7,500 to

10,500 residences over a 50 year period across 66,000 acres in Alachua County, Florida.

Using the CommunityViz® extension for ArcGIS, we generated grid cells of 1 square hectare across the site and assigned one of 16 land uses to each cell across a natural-to-urban transect. A wide range of attributes were defined for each land use. Placement of land uses was guided by composite scores of development suitability calculated for each grid cell based on existing ecologic, hydrologic, and soils characteristics, and infrastructure proximity.

Results: Trends suggest an inverse relationships between residential density and most measures of development impacts. On a per-capita basis, residential energy consumption decreased 27 to 38 percent, water consumption decreased approximately 50 to 75 percent, vehicle miles traveled decreased 12 to 36 percent, and GHG decreased 31 to 43 percent from the base Scenario.

Conclusions: CommunityViz®, informed by local data, can support an iterative planning process that immediately updates the impacts of various "what if" questions leading to more sustainable landscape and urban planning decisions. Further research could improve the accuracy of input assumptions and extend the model to include costs for long-term infrastructure maintenance and community services to differing types of development as well as feasibility of public transportation.

Performance and Energy Efficiency Analysis of Join Algorithms on GPUs - Ran Rui, Hao Li, Yicheng Tu, University of Florida

Implementing database operations on parallel platforms has gained a lot of momentum in the past decade, due to the increasing popularity of many-core processors. A number of studies have shown the potential of using GPUs to speed up database operations. On the other hand, energy consumption has also become an important performance goal in modern computing system design. Energy has become the second largest cost in maintaining today's IT infrastructure. In a data center environment, it also has profound effects on the design and operational cost of cooling systems. With the energy efficiency of CPUs steadily increasing in the last decade, the GPU industry is also making every effort to make GPUs green in addition to increasing computing capability and memory bandwidth. In the Top500 list of supercomputers, 10% of them have deployed GPUs not only for improved performance, but more importantly for less energy consumption. In this work, we present empirical evaluations of a state-of-the-art work published in SIGMOD'08 on GPU-based join processing. To conduct a comprehensive comparison, we test multiple CPUs and GPUs that covers mainstream and server level hardware. From the experiments, we find GPU achieve up to 20X speedup over its CPU counterpart. Apart from superior performance, GPU also provide with high energy efficiency more than we expected. We notice that although GPUs has much higher power profile than CPUs, the total energy consumption is significantly less than those of CPUs. Specifically, the latest GTX980 featuring the fully redesigned Maxwell architecture achieved 14X energy efficiency in comparison with the same priced high-end Core i7 CPU. In a server level comparison, the GTX Titan featuring an earlier architecture achieved up to 5X energy efficiency against the low power edition of Xeon E5 CPU. These findings indicate GPUs have done better than CPUs along the way to energy efficiency, although CPUs have made significant progress in reducing power consumption. GPUs might be a promising computing platform as it provides both performance and energy efficiency that are needed for data centers, data warehouses and other enterprise-level and scientific applications.

Smart Meter Data Analytics – Using Data for Energy Efficiency – Kevin Burns, Orlando Utilities Commission

Meter data has been used by utilities for decades with various focuses on use and often limited availability. Within the past several years the interest in smart meter data and its use for energy efficiency has steadily increased from both private and public sectors. Orlando Utilities Commission (OUC) has made significant stride in developing the infrastructure and analytic tools for smart meter data usage viable for both internal and external customers.

Take a glimpse into how OUC is developing use cases and studies around smart meter data analytics and employing efficiency as a result. Our desire is to demonstrate good stewardship of our smart meter data to set the example for our community and avail the tools and resources needed for our customers to join in the journey.

Dynamic Power-Aware Disk Storage Management in Database Servers - Peyman Behzadnia, Yicheng Tu, University of South Florida

Energy consumption has become a first-class optimization goal in design and implementation of data-intensive computing systems. This is particularly true in the design of database management systems (DBMS), which was found to be the major consumer of energy in the software stack of modern data centers among all database components, the storage system is the most power-hungry element. Therefore, we present our research on designing a power-aware database storage system. In previous work, dynamic power management (DPM) techniques that make real-time decisions to transition the disks to low-power modes are normally used to save energy in storage systems. However, DPM methods in the previous work usually suffer from some limitations such as non-optimal disk state configuration, in-efficient inter-disk data migration, and little energy saving or significant performance degradation due to spinning disks up and down. We tackle the limitations of existing works in our solutions. We introduce a DPM optimization model that can be integrated into the DBMS's data management engine in order to minimize power consumption of the disk-based storage system while satisfying the given performance requirements. It dynamically determines the state (power mode) adjustment and inter-disk fragment migration to achieve the optimal balance between power consumption and the query response time. We evaluate our proposed ideas by running experimental simulations using several synthetic workloads based on popular TPC benchmarks. Our results show an energy saving of up to 60% while satisfying the performance goals.

Dynamically Controlled Smart Walls - The New Standard for Home and Building Construction – Justin Zhou, Julius Regalado, IVy Composites, Inc. (Poster Only)

The current housing and building market relies heavily on wood and concrete for infrastructure materials. Currently insulation performance is highly dependent on geometry and typically higher insulation values require larger footprints. We have developed a cost competitive, smart insulation panel for the smart home and building of the future. IVy Composites' patent pending Dynamically Controlled Smart Walls (DCSW) will increase insulation values by over 100% while reducing space constraints. It also offers real-time climate control and energy use feedback, allowing for maximum efficiency. Our DCSWs may also be composed entirely of our patent pending natural fiber composite materials made from 100% recycled materials.

Although there are many standard insulation materials available for the purpose of providing thermal isolation between systems, these traditional insulation materials utilize a relatively static structure and composition governing their thermal characteristics. Static insulative materials such as wood, plastic, expanded polystyrene and concrete are widely used for the construction of homes and buildings. Each of these materials has certain characteristics that are suitable for a given application, but they cannot be dynamically altered in real-time to meet demands for variations in temperature or climate. There are vacuum panels in practice for high R-value requirements, but they suffer from loss in performance over time due to the inability to maintain their initial vacuum condition.

Our DCSWs can be pumped with active vacuum for superior thermal and sound insulation, but they can also be filled with fluids to further accommodate changes in the environment. They can be pumped with cold water during the summer or hot water during the winter. An additional benefit of filling with water is safety in the case of a fire. Being filled with water allows our DCSWs to act as a thermal sink and will not catch on fire; rather they will heat up the water inside and evaporate the contents. The smart walls will have an additional sprinkler function to release the water or fire suppression contents in the case of a fire outbreak.

The DCSWs are compatible with current construction standards so they can also be retrofitted into existing establishments as well as accommodate lines of studs for nails. IVy Composites' DCSWs have smart sensors, which can detect a faulty panel or vacuum seal and they can be replaced individually. All of this data is displayed in real-time and can be controlled by a wall panel and/or a tablet or smartphone. The user can also control characteristics of individual walls in the home or building. For example, one room can be cooler or warmer than another, or the bedroom can be quieter from outside noise than the living room.

The IVy Composite DCSW will be a very cost effective solution for superior thermal and sound insulation in a home or building. They can also be filled with fluids for further temperature management and fire retardation, and also offer real-time feedback to the user.

Track II: Smart Grid & Energy Storage

Dispatchable Micro-CHP and Micro-CCHP - Stephen Welty, Calor Technologies, LLC

Micro-CHP systems have been commercialized and used widely in Europe but their deployment is limited by the economics of having heat led operation algorithms. The heat engines used in micro-CHP systems have lower electric efficiencies than central power plants so are only used when a heat demand exists for hot water or space heating. This leads to considerable idle capacity when no local heat demand exists. This presentation discusses three methods to improve the utilization of this distributed power resource.

The first is to combine existing micro-CHP systems with a heat driven cooler so that the cooling demand can be converted into a heat demand that the micro-CHP system can supply and can therefore run for longer periods of time, possibly improving the economics of the system if heat driven cooler costs can be low enough.

The second is to incorporate these distributed power resources into a smart grid so that they can be used as peaking plants and only used at periods of atypical grid performance. This method would utilize the lower efficiency electric power from micro-CHP systems to allow the grid to ride through excursions that are out of the ordinary and avoid the building of capital intensive power plants for this purpose that remain idle most of the time.

The third method is to design new devices that can provide dispatchable micro-CCHP. Calor Technologies has patents on a new device that can operate as a cooler or power generator with low temperature heat input. By varying the inlet temperature to the device, it can be modulated from power generation only to power generation and cooling and then at low temperature heat driven cooling only. If the temperature is under 100C then the system can still use the heat in a heat assist operation but using electric input power to complete the energy input required.

A New Way Forward for Energy Companies: Cloud & Mobile Technologies - Ben Amaba, Ph.D., Professional Engineer, CPIM®, LEED® AP BD+C, IBM

A combination of technical advances and new thinking about Energy Systems has created one of the most profound changes that affect us personally and professionally: a digital revolution – the Industrialization of Information Technology using Cloud and Mobile innovations to new ways to engage customers, employees and partners with big data and analytics, mobility and social media. No enterprise or person is immune—all must transform and speed is of the essence.

Companies and utilities are deploying Cloud and Mobile technologies faster, cheaper and at higher service levels than ever before. Many organizations have recognized integrating Cloud and Mobile innovations bring about productivity, efficiency and safety. Every organization has to better understand the changes as a matter of discussion whether or not they believe it could change their environment, if it has not already. Like the energy utility industry, Cloud and Mobile technology is maturing where utility pricing (pay only what you use), online access independent of location, on-demand access when needed (reliability and availability), and common infrastructures are allowing utilities, governments and companies to deploy information and data solutions at less cost and latency, higher security, measurable productivity gains and leverage global resources.

It took 80 years for the automotive industry to penetrate 90% of the market while it took 4 years for the mobile market to do the same. New smart phone applications linked to data in the Cloud are now being leveraged without the delays or high capital costs the market experienced a few years ago. Analyzing weather data and energy consumption can keep the lights on. Energy and utilities firms say weather causes 70% of the outages (Congressional Research Service 2012). The Apple IBM App, Field Connect, is transforming the way field technicians do their jobs with powerful, data-driven information right on iPhone then up to the Cloud for weather information. In or out of a service truck, field technicians can get up-to-the-minute details based on their location to help keep safety top of mind. Push notifications provide late-breaking news on severe weather while outages, hazards, and crewmember information can be viewed at any time. Personalized training and safety tips are available on demand, empowering field technicians with even more ways to assess and mitigate risk factors. And the intuitive user interface on iPhone makes it easy to get field teams up and running in no time. With access to Twitter, Apple, and Weather Data from the Cloud coupled with the latest mobile technologies, significant advantages and benefits are born.

The benefits and growth have never been experienced and are transforming Energy Systems globally. The presentation will discuss the transformations and disciplines needed to take advantage of the opportunity.

eNOS - An Open Source Energy OS - Raymond Kaiser, Amzur Technologies

eNOS is an open source energy operating system we are developing designed to provide Dynamic Demand Management by integrating demand management with solar power and battery storage. eNOS will accelerate the transition to distributed renewable energy by providing a cost-effective platform to reduce on-site peak demand by 20 to 30%.

The centralized power generation model has served well. It delivers safe, reliable and affordable electricity throughout the world. But over 1.2 billion people have no access to electricity. And electric power generation is the largest single contributor to greenhouse gas emissions.

In less developed countries, eNOS allows small villages to share expensive resources (solar panels and batteries) and, by controlling peak demand, reduces the investment to reliably supply power where and when it is needed. In developing countries, where power delivery can be unreliable, eNOS can reduce reliance on diesel generators. In the developed world, eNOS will allow individuals and organizations to more cost-effectively develop carbon neutral buildings and campuses and to reduce demand charges.

Real-time, distributed energy management is a complex challenge that can be broken into distinct modules. In a classic book on design the authors the authors make a broad and compelling case that “the computer industry has experienced previously unimaginable levels of innovation and growth because it embraced the concept of modularity, building complex products from smaller subsystems that can be designed independently yet function together as a whole. (They state that this approach)… is deeply rooted in the very nature of things.”

How will we proceed? The Historic Green Village (HGV) is a small, mixed use campus of 5 buildings on Anna Maria Island. It includes 87 kW of solar PV and a power distribution system with a single point of common coupling to the utility. The team has already implemented an Energy Dashboard at the Historic Green Village that provides detailed minute-by-minute circuit level data by building and load type. We have done a detailed analysis of load and solar production data collected over the last 3 years.

Each of the 8 commercial and residential units will have a wall-mounted load controller and wireless sensors (temp, humidity and occupancy) and switches for select electrical and mechanical equipment. We will also install a 24 kWh smart battery system. The eNOS system has two primary services: dMAN, the Dynamic Demand Manager, and batMAN, the energy storage management module. The system will be designed to reduce peak load by 20 to 30% while maintaining quality of services. The Demand Manager is based on software tools and standards developed at two US National Energy Labs (PNNL and Lawrence Berkley). The Battery Controller was developed by Tumalow Energy Systems, an Amzur business and co-development partner.

A technical success that fails in the marketplace will have little impact on addressing the global energy and environmental challenges that humanity now faces. The Internet of Things: low-cost controllers, sensors and switches provide an excellent platform to deliver Dynamic Demand Management. This capability has multiple impacts: 1. Financial. Lower demand charges benefit commercial customers that have invested in solar PV but are still incurring demand (kW) charges despite lower energy (kWh) charges; 2. System. In the US 20% of the peak load happens less than 5% of the time. Demand Response reduces the need for utilities to invest in additional generating capacity to meet peak demand; 3. Environmental. Generation brought on-line at last resort (peak periods) are typically the least efficient, and most polluting generating assets; 4. Investment in new technology. Real-time, customer-driven (vs. utility driven) Demand Management significantly improves the business case for stationary battery storage.

Global investment in the power sector increased almost two-and-a-half times from $290 billion in 2000 to $690 billion in 2011. And investment in generation is designed to exceed peak load by some margin, i.e. spinning reserve of capacity exceeds total peak demand to compensate for unexpected outages. In the US 20% of the load happens only 5% of the time. In Australia 15% of the load happens less than 1% of the time. In Egypt 15% of the load happens only 1% of the time. Therefore a significant amount of capital investment sits idle 95% of the time. Utilities have encouraged Demand Response programs but the monetary benefits to customers are slim so adoption levels have been modest. eNOS targets reducing Demand Charges – the capacity charges that commercial customers pay every month. Historic Green Village, even though it is Net Zero Energy, often incurs a Demand Charge since their energy demand (kW) exceeds a specific threshold within a 30 minute interval during a billing period. The combination of intelligent load shedding and reduction (i.e. reduce setpoints or dim lights) and battery storage can reduce or eliminate demand charges. Our objective is to reduce peak demand by 20 to 30%.

The real accelerator in market transformation across a wide range of industry sectors has been to allow subject matter experts to leverage open source tools to focus on the problem sets they understand best. In our select domain these challenges include solar and demand forecasting, load shedding, metering and measurement, energy analytics, sensors and switches, and machine-to-machine communications. The team carefully evaluated Volttron an open source agent development and deployment platform for managing distributed generation and demand-response developed by the Pacific Northwest National Labs. Volttron is well thought out and has been proven in the lab and in limited field trails. But there is scant community development support. One of the few contributors provides source code to a more complete product but the attendant license is quite restrictive. We chose openHAB as the automation bus to implement a Dynamic Demand Management suite of applications. openHAB is vendor and protocol neutral; is field-tested; supports a wide range of devices, protocols and technologies; and has a large, active and global community of contributors.

We have also chosen Green Energy Corp's Greenbus enterprise service bus. Greenbus is specifically designed to support micro-grids. It is based on well-supported open-source communication protocols and technologies and the same modular OSGI framework as openHAB.

In short, we are aimed at providing a low-cost, open source set of services and tools to manage energy demand and supply locally. This will accelerate the transition to distributed energy systems.

High Impedance Fault Detection on Distribution Networks: an Adaptive Approach Considering a Noisy Environment - Arturo Bretas, Leonardo Lurinic, Renato Ferra, University of Florida

Power networks control, protection and diagnosis are usually addressed by three-phase voltages and current signals analysis based methods. Therefore, disturbances detection, which is essential for protection and diagnosis purposes, must be made by means of these aforementioned signals. Faults are disturbances that generate transients in voltage and current signals because of rapid system states change. In this context, real-time detection of transients provides an estimate of the anomaly inception and serves to initiate protection action or signals recording. On the other hand, data bases of digital signals are also made available in real-life. Thus, an important task is to detect and classify all disturbances contained in them. Solid faults produce clear visible transients followed by a substantial change in voltage and current magnitudes. By contrast, High Impedance Faults (HIF) show very smooth features including low energy transients which can be easily mixed up with noise. In order to deal with above problems, many research works where proposed and commercial equipment developed. One common approach is based on the difference between the output of a median and a mean filter. Also sample-by-sample or cycle-by-cycle difference detection based methods are also very used. Details of a Discrete Wavelet Transform are another way proposed for detection signals generation. This work proposes a Park´s Transformation based approach for High Impedance Faults Detection. The dq-transformation (DQT), using only the direct and quadrature signals are used in this approach. A new insight of the mathematics behind DQT is also presented for generalized signals. A scheme of FIR adaptive filter is used to improve detection signal quality and finally a detection algorithm is proposed whose is self-adaptive with the noise level of the signal. The proposed solution is currently being used on a Distribution Utility for High Impedance Fault Detection on Distribution Networks.

Smart Fridge / Dumb Grid : Architecture for the Electricity Network of 2020 - Y. Chen, J. Ehren, R. Kaddah, J. Mathias, P. Barooah, A. Busic, Sean Meyn, University of Florida

New FERC rules require that ISO/RTOs provide incentives to responsive resources to help balance supply and demand in the power grid (e.g., the 2011 FERC Order 755). Since the recent adoption of "payment for performance" at PJM, they found that their overall costs were reduced, even with the higher payments to ancillary service providers that were mandated by FERC. A potential explanation: with higher accuracy comes reduced capacity requirements for zero-energy ancillary services.

Using arguments from classical control, it is argued that this explanation is valid for services in a narrow frequency range. It makes sense to pay a premium for accurate regulating reserves in this range, while the value of accuracy is not so great in lower frequency bands. This is excellent news for implementation of ancillary services from flexible loads:

1. Plentiful high-frequency regulation service: In research conducted at the University of Florida it is shown that loads in commercial HVAC systems can provide the valuable high-frequency regulation with negligible cost.

2. Reduced communication needs for lower frequencies: In joint Florida/Inria Paris research it has been shown that with additional communication infrastructure, lower frequency regulation with high accuracy

can be obtained from on/off loads such as chiller systems, refrigeration, water heaters, and residential pool pumps (a load of approximately 1GW in Florida). The good news is that two-way communication may not be required: If intelligence at the loads is designed appropriately, then the grid will obtain the required regulation with only one-way communication from balancing authority to these intelligent loads.

Develop Smart Power Inverters to Improve the Performance of Smart Power Grid - Shuo Wang, University of Florida

A high power, multifunctional smart power inverter is investigated to integrate PV energy source, energy storage, electric vehicles (EVs) and power grid. The smart power inverter can control the power flow between PV energy source, energy storage, EVs and power grid. It can achieve multiple functions including reactive power compensation, harmonic compensation, load balancing, EV charging, real power generation and grid voltage regulation. It aims to improve smart grid performance and replace existing single function grid devices so that grid infrastructure cost can be greatly reduced.

Home is Where the Heart Is: Complexity, Pattern, & Meaning in Short Interval Residential Electric Smart Meter Data - Hal S. Knowles, III, University of Florida Program for Resource Efficient Communities

To paraphrase Albert Einstein, "we cannot solve today's problems with yesterday's thinking." By their very name, normal statistics and linear dynamics are rooted in a scientific conventional wisdom that assumes nature behaves as a straightforward sum of its parts. I am here to suggest that new thinking, and new solutions, await us in other dimensions….fractal dimensions.

Right now, we stand on a fractal shaped peninsula. Interestingly, there is no single measure of length to describe the Florida coast. As our ruler gets ever smaller, the coast of Florida appears ever longer, revealing increasingly more subtle details. Now imagine the challenge of using this same basic ruler to capture the shape of a tree. These objects, and the systems that generate them, are too complex to be described by the 0 dimensional points, 1 dimensional lines, 2 dimensional planes, or 3 dimensional solids of Euclidean geometry.

Fractals are rough, self-similar, and iteratively branch across space, but also within time. Like Goldilocks, our lungs respire, our brains fire, our postures sway, and our hearts beat with fractal complexities that are neither too simple and regular nor too disordered and irregular. At our healthiest, we are adapted for uncertainty and prepared to change in response to our dynamic surroundings.

For the benefit of both humans and planet, I have dedicated the last 20 years of my life to researching and promoting the more efficient use of energy and water resources in residential buildings. Our past thinking assumed buildings were simple machines, with known variables, whose performance could be perfectly engineered. We measured consumption in monthly billing intervals and differentiated the good from the bad by the normal statistics of means, variances, and sums.

Yet the predicted outcomes from this asset modeled approach to building performance were often wrong…sometimes wildly. What was their fatal flaw? We forgot that all machines have both programmers and users.

Our present thinking integrates human behavior into the equation. Human plus machine, turns house into home. We now assume, that with enough due diligence we can integrate these behavioral variables into our operational models and reengineer our homes accordingly. Or so we think…and therein lies the problem.

We measure our building performance and occupant behavior with the same coarse grained ruler that fails to describe the dynamics of our ever evolving Florida coast. We have simply boxed our human nature into a clockwork concept of the original machine, as if robots are the operators.

Our future thinking will use dynamical models to treat our buildings as organisms and our cities as ecosystems. If Pliny the Elder was right, and home is where the heart is, then I believe the fate of the smart grid and the state of home health hides in the space between its beats. As such, my FESC funded graduate research applies the science of chaos and fractal dimension to describe, diagnose, and improve home performance from electric smart meter data as if this signal is the heartbeat of the home.

Fault Location Identification in Smart Distribution Networks with Distributed Generation - Jose Cordova, Omar Faruque, Florida State University

Power lines in distribution networks are subject to conditions such as bad weather, contact with animals and trees, equipment malfunction, etc. These conditions may cause a fault in the power lines that may damage the devices in the network if the fault is not cleared by the protection devices present. For a sustained fault, it is required to identify the type, cause and its location as soon as possible. In this work, a fault location identification algorithm is proposed that can accurately identify the fault location within seconds so that utilities can have a better understanding of how to mitigate the fault and restore the service. The algorithm uses data collected from the measurements available from the smart grid devices such as Advanced Metering Infrastructure (AMI), Reclosers, Power Quality Meters, and other smart meters present in the grid. It is also suitable for distribution networks with Distributed Generation (DG) and smart measurement infrastructure that can transmit event-driven data such as pre and post-fault voltages or currents. To overcome the challenge presented by the lack of metering points at every bus of the system, this research work presents a MATLAB-based state estimation (SE) technique that is used to identify the fault location in Real-Time. The validation of the algorithm was performed by using the IEEE 37 nodes test feeder on which PV systems were added to represent DG penetration. The network is modeled inside a real-time simulation platform Artemis developed by Opal-RT technology. The model was running in real-time and streaming data out through PMUs placed at different location using the IEEE C37.118 standard. Fault-on voltages and currents from virtual smart meters/PMUs are gathered in real-time, fed to the State Estimation algorithm to determine the unknown phasors which are then fed to the fault location identification algorithm. When a fault is created in the real-time simulator, the Graphic User Interface (GUI) of the algorithm displays the location of the fault within a second. This will be a great tool for utility operators who can inform the potential fault location to the maintenance staff. The method was tested for different transformers configuration, for multi-source distribution grid with the presence of DG, and for symmetrical and asymmetrical fault types. In most cases the accuracy is above 90% at first guess and in cases of the remaining 10%, a second guess made the right call.

Real-Time Digital Simulation Based SCADA Lab and HIL Machine Drive Lab at USF - Hossein Ghassempour, Zhixin Miao, Lingling Fan, University of South Florida

This poster presents the setup of a HIL electrical machine drive lab and SCADA lab for wide area measurement and control. In both settings, OPAL-RT's real-time simulators RT-LAB are implemented. In the drive lab, OPAL-RT is used to implement the desire control schemes for AC and DC electrical machine drives. Control blocks and measurement signals are created with MATLAB/Simulink. RT-LAB software compiles MATLAB/Simulink files to C code and download it to OP-4500 OPAL-RT simulator. PWM signals are generated by OP-4500 I/O boards and command signals are sent to power electronic boards to drive DC or AC machines.

The SCADA testbed will be used to implement energy management schemes, test power grid cyber attacks and mitigation strategies. Phasor Measurement Units (PMUs) hardware devices equipped with GPS antennas are used to capture data from real-world power systems as well as simulated power networks in OPAL-RT. Captured data will be sent to an OSISoft PI server database via IEEE-C37118 protocol. All the communication and data exchange are used to develop a SCADA energy management test bed. The test bed will help researchers to analyze and compare various algorithms and protocols for smart grid control as well as mitigation schemes for power grid cyber security.

Nickel Iron Batteries for Twenty First Century Energy Storage - David Atherton, Randy Ogg, Encell Technology

Encell Technology was founded in 2006 as a venture funded startup to develop new energy storage solutions. Encell has focused for the past six years on developing electrochemical storage technologies for micro-grid and renewable energy applications. Encell is located in the former GE/Gates/Energizer/Moltech alkaline battery facility in Gainesville, FL. The Encell team has decades of experience in the battery industry successfully launching many new products.

The Nickel Iron (NiFe) battery is one of the oldest battery chemistries to have been commercialized. The chemistry was championed by Thomas Edison and competed against lead acid for every energy storage opportunity, including large format. Edison believed it was the superior battery chemistry since it had an almost infinite cycle life. It lost out to lead acid due primarily due to its limited rate capability.

Edison's original NiFe battery, capable of storing one hour of electrical energy, could not receive or discharge that one hour of energy any faster than at a 16 hour rate.

Encell Technology, however, has been able to overcome this limitation. Encell has combined the original Nickel Iron (NiFe) Edison invention with modern battery manufacturing processes and advanced materials to produce a product that exhibits the benefits of the original technology with none of the drawbacks. In short, and proven by results, the Encell NiFe electrochemical storage system currently boasts the following very attractive attributes:

- 20 year life
- 10,000 cycles to 80% DOD
- 2C charge acceptance that improves with age
- Over 90 percent nameplate capacity at 3C discharge
- Exceptional high temperature tolerance
- 60 percent nameplate capacity at -20C; 25 percent at -30C
- Unrivaled safety & abuse tolerance

At the most recent count, Encell has in the field 361 kWH of installed energy storage. These are 33 separate installations with 2042 individual cells. The cell count is 1,550 100AH cells and 484 300AH cells. With 6 months of committed production and customer contact daily, Encell has "Nickel Iron Batteries for Twenty First Century Energy Storage".

G4 Synergetics High Power Battery - Mark Kohler, G4 Synergetics, Inc.

G4 Synergetics has developed a next-generation NiMH battery that is capable of continuous operation at 8C-Rate and full charge/discharge cycles at 16C-Rate. The battery module features a unique construction with integrated air-cooling, BMS, and overcharge protection. G4 is targeting a number of different applications for this technology including:

- Hybrid line-of-road locomotives
- Electric buses that require ultra-fast recharge capabilities
- Grid storage
- Military applications
- Many other high power/high temperature/long life applications

G4's battery architecture eliminates welded connections between cells that have been typically used in battery packs as well as other key features within the electrode stack to lower resistance. Together, these features give the battery stack an enlarged current path thus reducing the overall resistance of the battery. The reduced resistance translates into lower battery temperatures, greater charge acceptance and the ability to charge at high rates.

The Impact of Double-use Storage on a Grid Connected House with Photovoltaics - Richard Aarons, Omonayo Bolufawi, Mark H. Weatherspoon, Florida State University

A major goal of sustainable energy systems is to provide clean, affordable, accessible energy that does not deplete the earth's resources. There is a need to develop reliable energy systems that do not rely on fossil fuels and fuels with toxic byproducts to preserve the environment while powering the future. This has led to the development of local, small power generating systems utilizing photovoltaics (PV) and wind power. There has been a rapid increase in energy generated from, and supplied to the grid, from PV. This increase in PV grid penetration can lead to grid regulation problems if the rapid increase in generation does not match the peak load demand. One way of limiting or controlling when power is supplied to the grid is through the integration of storage. Storage systems can also be implemented to increase the efficiency of a system by storing energy that would otherwise be dumped when generation exceeds load requirements. By the same token, storage can also determine when power flows to and from a system. Battery storage also allows for increased self-usage, autonomy and can provide grid services such as peak shaving, regulation, spinning reserves and even arbitrage.

One of the challenges of implementing battery storage is the relatively high cost of batteries. Plug in hybrid electric vehicles (PHEV) have been considered for use as storage in various grid connected systems. Future smart and micro grids could benefit from the flexibility of integrating electric vehicles as part of the energy network to provide vehicle-to-grid services (V2G). Research shows that the average car is parked 15 hours a day and can provide storage and or grid services 60% of the time.

In this work we use MATLAB-based code to analyze the impact of double-use storage on a grid connected house with photovoltaics in Tallahassee, Florida. We examine the use of a plug in electric vehicle (PEV), as double use storage, to provide battery storage for an average-sized residential house with PV. The PEV's battery will be the only local energy storage system connected to the residence when present. The PV provides the renewable energy, and the grid is used to provide power to the house and charge the car when the PV is not providing enough energy. Grid relief is provided by the PV when the car is charged and the load requirements are met. The system employs net-metering by which excess PV production during peak hours is sent to the grid for credit to offset overall grid prices. The results show that the cost of purchasing power from the grid can be reduced with the use of a PV and PEV integration. The PEV can be used as an uninterruptible power supply (UPS) to power the load in the absence of the grid and the PV.

Analysis of Coupling Dynamics for Power Systems with Iterative Discrete Decision Making Architectures - Zhixin Miao, University of South Florida

Iterative "learning" by distributed control agents has been proposed for power system decision making. Such decision making can achieve agreement among control agents while preserving privacy. The iterative decision making process may interact with power system dynamics. In such cases, coupled dynamics are expected. The objective of this paper is to propose a modeling approach that can conduct stability analysis for these hybrid systems. In the proposed approach, the discrete decision making process is approximated by continuous dynamics. As a result, the entire hybrid system can be represented by a continuous dynamic system. Conventional stability analysis tools are then used to check system stability and identify key impacting factors. An example power system with multiple control agents is used to demonstrate the proposed modeling and analysis. The analysis results are then validated by nonlinear time-domain simulation.

The continuous dynamics models developed in this paper sheds insights into the control nature of each distributed optimization algorithm. An important finding is documented in this paper: A consensus algorithm based decision making may act as an integrator of frequency deviation. It can bring the frequency back to nominal while the primal-dual based decision making cannot.

Modeling of Packed Bed Thermal Energy Storage with Encapsulated Phase Change Material - Francesca Moloney, University of South Florida

Although concentrating solar power (CSP) plants are becoming more popular and cost effective, one major setback is the implementation of storage. One type of storage is a thermocline packed bed system, where the filler particles store excess thermal energy and transfer it to the heat transfer fluid when solar radiation is not available. A model was developed to simulate a packed bed thermocline system with encapsulated phase change material (PCM) as the filler. The model was validated with experimental results. The model is also being used to analyze the effects of the packed bed parameters on the exergy efficiency of the storage system.

ADDITIONAL POSTER SESSION
Wednesday, May 20 - 5:25 pm - 5:55 pm

RENEWABLE/ALTERNATIVE [POWER AND STORAGE (POSTER SESSION)

***Sustainability in Rapid Prototyping** - Joseph Prine, John McCormack, Ryan Integlia, Jaspreet Dhau, Sesha Srinivasan, Jorge Vargas, Florida Polytechnic University*

Rapid prototyping is a versatile technology, one form of which is 3D printing, which has the potential to become a viable manufacturing process. 3D-Printers utilize stock material thermoplastics like Polylactic Acid, a biodegradable plastic, or Acrylonitrile butadiene styrene, a common thermoplastic. This project proposes a smart manufacturing system with a focus on sustainability, utilizing 3D printing techniques with recyclable material. This system would be automated and easy to use. Pick-and-place robotic systems could introduce non-printed components, like circuit boards, into the product as it is being printed. The stock material could be sourced from 3D printer waste, or even recyclables like plastic bottles. Material additives could be mixed with this source material to create stock material that has additional properties, like magnetic properties, high electrical conductivity, elasticity, and/or toughness. The final design of this system will be able to be scaled from a single unit to an entire automated factory, depending on need.

BIOMASS (POSTER SESSION)

Dual Purpose Benefits of the Sweetpotato Crop: Biofuel and Animal Feed - Lara R. Nesralla, Wendy A. Mussoline, Ann C. Wilkie, University of Florida-IFAS Extension

Sweetpotato, Ipomoea batatas L., is a highly nutritive crop grown in many developing countries and it is commonly grown as a low-cost food resource. In Florida, however, sweetpotato is being considered as a viable biofuel crop to replace declining citrus groves. It is advantageous because of its rusticity, low maintenance and high adaptability to extreme conditions such as droughts and flooding. An industrial variety (CX-1) has roots with high dry matter and starch content, which results in high ethanol yields compared to other common feedstocks such as corn and wheat. The sweetpotato crop offers both a root yield and an above-ground leafy biomass (aerial vines) that can be used as a nutritious animal feed supplement. Although the fresh vine yield often exceeds the root yield on a per hectare basis, the potential value of the vines is often overlooked. The vines can be fed fresh or dried, or they can be ensiled and stored for use during the less productive periods of the year when pastures are not available. The ensiling process involves a fermentative process in which bacteria produce lactic acid by utilizing substrates such as soluble sugars and organic acids. During this process there is a decrease in pH and an increase in temperature and ammonia nitrogen. The fresh material is cut, compacted, stored in a silo, and sealed to protect it from yeast and mold growth. When ensiling is conducted properly, the nutritive value of the silage will be preserved and digestibility will be improved since the cell wall components are broken down during the fermentation process.

The objectives of this research were to determine the fermentative capacity (FC) index of sweetpotato vines and to evaluate the forage quality of both fresh and ensiled vines. FC is dependent upon moisture content, buffering capacity and soluble carbohydrate concentrations. The FC index was measured for seven varieties of sweetpotato vines and the averages for both the fresh (38) and wilted (37) vines exceeded the minimum capacity (35) required to promote lactic fermentation. Fresh and ensiled vine characteristics, including dry matter, crude protein (CP), and neutral detergent fiber (NDF), were assessed for five different sweetpotato varieties. The average CP of fresh and ensiled vines was 12% and 13% DM, respectively, which both exceed the minimum CP of 7% DM recommended for optimal digestibility. CP represents the nitrogen content of the feed, which is necessary for anaerobic bacteria to carry out fermentation in the rumen. The average NDF concentration for fresh (35% DM) and ensiled vines (44% DM) were both within the optimal range of 25-60% DM to supply ample nutrients without discouraging voluntary intake of the feed.

The results indicate that the ensiling process is ideal for sweetpotato vines based on their fermentative capacity and the conservation of nutrients. Sweetpotato vines can be a highly nutritious, low-cost alternative to grain-based feeds to support livestock year-round. Thus, the sweetpotato crop offers a dual purpose production for both biofuel (from roots) and animal feed (from vines).

Cultivation of Filamentous Algae for Bioenergy Production - Kimberly D. Hafner, Ann C. Wilkie, University of Florida-IFAS Extension

Algae are high-yielding plants and a potential alternative to conventional fossil fuels that can alleviate the greenhouse effect while simultaneously treating wastewater. Cultivating algae requires high nitrogen inputs to sustain growth and produce feedstock biomass, providing a possible bioremediation option for high-ammonia wastewaters such as stillage from cellulosic ethanol production. Utilization of stillage for algae growth can offset the energy consumed in the pretreatment and distillation operations of bioethanol production by providing algal biomass for conversion into biofuels. In addition, algal biomass can serve as a feedstock for anaerobic digestion to produce methane-rich biogas.

The objective of this study was to develop optimal cultivation methods for maximum biomass yield of Spirulina, a filamentous cyanobacterium. Spirulina is a robust algal species due to its ability to thrive in alkaline environments. Its size and filamentous morphology allows for manageable harvest, thus minimizing costs and energy consumption for biomass recovery. Spirulina was cultivated in Modified Zarrouk's Medium with sodium bicarbonate as the carbon source. Subcultures were prepared with 10% inoculum in 1L vessels (500 mL active volume). Cultures were illuminated at 250 µmol photons/m2/s on a 12:12 photoperiod. Algal growth was monitored by spectrophotometry using absorbance at 680nm.

The effect of culture vessel geometry on biomass growth was evaluated. Using an orbital shaker as the mixing method, the results indicated that biomass growth rate was much higher using a Roux culture bottle (13.4 mg/L/h) compared to an Erlenmeyer flask (7.9 mg/L/h). The high biomass yields for the Roux bottle were likely due to better light penetration into the growing culture because of the greater surface area-to-volume ratio in the Roux bottle (98.7 m2/m3) versus the Erlenmeyer flask (41.3 m2/m3). The shape of the Roux bottle reduces self-shading of cells in the culture which results in higher growth rates in comparison to the Erlenmeyer flask. The Roux bottle culture also displayed more mass transfer and turbulence during rotational mixing.

The effect of mixing strategy was also evaluated. Using Roux bottles as the cultivation vessel, mechanical shaking (120 rpm) and aeration mixing (4.0 L/h) methods were compared and similar biomass growth rates (13.4 and 13.5 mg/L/h, respectively) were observed. In theory, mechanical shaking has the distinct advantage of reducing ammonia stripping which retains the nitrogen in solution for algal uptake, thus promoting biomass growth. Based on observation, the shaker promotes better mass transfer between the culture medium and algal cells, and increases frequency of cell exposure to light and dark zones. However, mixing speeds must be closely monitored since excessive mixing can create shear forces that lead to filament fracture. Also, aerators result in a loss of water by evaporation, which can potentially increase salinity levels if working with saline media such as stillage and wastewaters. Further research will be conducted with a focus on utilizing stillage as a cultivation medium and evaluating Spirulina's potential as a phycoremediator and biofuel feedstock.

Impact of Phytohormones on Microalgal Growth and Lipid Content - <u>Brett S. Nelson</u>, Ann C. Wilkie, University of Florida-IFAS Extension

The confluence of increasing energy demand and uncertain fuel reserves has sparked a need for research in alternative energy, and specifically, biofuels. Microalgae are potential feedstocks for biofuels because of their fast growth rate and ability to produce lipids that can be extracted and converted into biodiesel. However, new methods of inducing high lipid contents and/or biomass growth are necessary for the production of algae biofuels to become economical. The objective of this research was to investigate the effect of exogenous plant hormones on microalgae biomass growth and lipid content. Plant hormones are signal molecules that regulate plant growth and development. Chlorella vulgaris, a locally isolated strain with demonstrated ability to produce lipids, was selected as the test organism. Chlorella vulgaris was grown in BG-11 standard growth medium. Plant hormones of the auxin (1-naphthaleneacetic acid (NAA)), cytokinin (trans-zeatin riboside (tZ)), and abscisic acid (ABA) hormone classes were added, individually and in combinations, to determine their impact on cell biomass and lipid content. All experimental trials were conducted in triplicate. Auxin and cytokinin plant hormones are known to aid in the stimulation of plant cell growth. ABA is known to improve stress tolerance and inhibit plant cell growth. Thus, the combination of these different plant hormones is expected to synergistically improve biomass yield and lipid production.

During the individual treatments of 1 ppm tZ, 5 ppm NAA, 5 ppm ABA, and 50 ppm ABA, there was no significant difference in biomass yield compared to the control. However, lipid yields for each individual treatment increased when compared to the control. The increase in lipid yields was correlated with increasing phytohormone concentrations rather than with the specific class of phytohormone evaluated. For example, the overall increase with the 1 ppm solution was 2.0 times higher than the control, while the 5 ppm and 50 ppm solutions were 2.8 and 3.4 times higher, respectively. There was no discernable difference in lipid yield between the treatments with 5 ppm NAA and 5 ppm ABA. Thus, increasing concentrations of phytohormones had the most significant impact on lipid yield during the singular treatments.

The three combination treatments of phytohormones were as follows: (A) 1ppm tZ + 5ppm NAA; (B) 1ppm tZ + 5ppm NAA + 5ppm ABA; and (C) 1ppm tZ + 5ppm NAA + 50ppm ABA. Each of the three combination treatments showed an increase in biomass yield over the control, with the most significant increase (47%) observed with combination (B). Combination (B) also had the highest increase in lipid yield (8.2 times the control) and was the only combination treatment that exhibited a synergetic interaction among the individual phytohormones. For example, combination (B) had a higher lipid yield when the three phytohormones were combined (11.5 mg) versus the additive improvement of all three phytohoromones applied singularly (10.6 mg). The other two combinations (A) and (C) showed diminishing effects when compared to the individual treatments. Based on the treatments evaluated, combination (B) is the optimal phytohormone applicaton for improving biomass and lipid yields in Chlorella vulgaris.

Techno-Economic Analysis of Bioethanol Production from Lignocellulosic Biomass: Process Integration with Energy Recovery from Wastes - <u>Na Wu</u>, Spyros Svoronos, Lonnie Ingram, Ismael Nieves, Pratap Pullammanappallil

Ethanol is the primary liquid biofuel produced on a large scale in US. Currently ethanol is produced from corn starch. However, concerns related to food security and prices, and environmental impact arising from cultivating and using a food and feed source for fuel production have prompted the utilization of more sustainable feedstocks for ethanol production. Non-food crops (mostly lingo-cellulosic in nature) and agricultural residues as feedstock for production of ethanol may alleviate these concerns. In this research an ASPEN (AspenTech, Cambridge MA) based process flowsheeting model was developed for a lignocellulosic ethanol biorefinery. All sections of a biorefinery including pretreatment, saccharification, fermentation and ethanol recovery were modeled. The flowsheet was validated using operating data from the pre-commercial scale Stan Mayfield Biorefinery Pilot Plant operated by the University of Florida. The Stan Mayfield Pilot Plant currently uses sugarcane bagasse as feedstock. The bagasse is subjected to a dilute phosphoric acid and steam explosion pretreatment to solubilize the hemicellulose and to free up the cellulose for subsequent saccharification using commercial cellulase enzymes. The saccharified bagasse is fermented to ethanol. Ethanol is recovered from fermentation broth by distillation followed by dehydration. An anaerobic digester was integrated to the process for treatment of stillage from the distillation units. Anaerobic digestion is a biochemical process that mineralizes organic matter to a gaseous biofuel called biogas containing 50-60% methane. Process operating data for simulation of anaerobic digester operation was obtained from laboratory scale experiments.

An energy analysis, using the validated flowsheet, was performed to evaluate energy consumption in various sections of the biorefinery. Possible process modifications to minimize energy consumption were also analyzed. The impact of introducing anaerobic digestion on the overall economics and energy balances were also investigated. Experimentally it was found that a liter of stillage contains sufficient organic matter to produce about 10 liters of methane (or about 17 liters of biogas). Through anaerobic digestion about 85 – 90% of the BOD of the stillage wastewater was also removed. It was found that biogas from anaerobic digestion can displace around 30% of fuel consumption in the plant.

Synthesis of Biodiesel via Supercritical Transesterification Route from Waste Cooking Oil - Z. Cerniga, Shriyash Deshpande, D. Townsend, K. Cogswell, A. Driscoll, A. Sunol, G. Philippidis, M. Pandey, University of South Florida

A continuous biodiesel production process is under development for powering the University bus system at the University of South Florida, by means of a portable production unit with a weekly capacity of 400 gallons of B100 grade biodiesel. Unlike conventional biodiesel production processes, the process is performed at supercritical conditions and does not require a catalyst. This eliminates the need to have a catalyst separation system and also saves on the large amounts of water required for the biodiesel wash. Along with the catalyst free operation, supercritical transesterification is capable of producing biodiesel with residence times of a few minutes, which makes the process novel in itself. The process is also tolerant to the presence of water in the waste oils. Heat integration between the hot products and cold reactants reduces the utility costs. The alcohols will be obtained from the university hospital wastes and laboratory wastes produced on campus. The process is designed to recycle the excess alcohol back to the system. Such provisions reduce the costs of raw materials, which makes the process sustainable. Glycerol, the byproduct generated from this process is relatively pure as compared to other conventional processes, and can be used for production of high quality soap or high-value pharmaceutical applications.

An orthogonal design is implemented to study the effects of various key process parameters on the biodiesel yield: temperature, pressure, residence time and molar ratio of alcohol to oil. The temperature of operation ranges from 250 C to 340 C and the pressure ranges from 1,500 to 2,000 psia. The alcohol is in excess, 2-8 times the stoichiometric amount. A response surface methodology approach is used to identify the optimum conditions for this process.

Gas chromatography-mass spectrometry (GC-MS) is used for determining the product composition. Methyl heptadecanoate (C17) is used as the internal standard to assist the quantification of methyl esters (biodiesel). The yield of esters is determined based on the peak area represented by each ester present, in comparison to the calibration of the internal standard. This method follows the EN14103 standard for biodiesel analysis. The poster presentation will report on the experimental progress, process scale up, analysis via gas chromatography and life cycle considerations.

SOLAR ENERGY (POSTER SESSION)

Avian Mortality at Solar Energy Facilities in Southern California - Stephanie Meyers, Lee Walston, University of Illinois at Urbana–Champaign

Renewable energy accounts for about 8 percent of the total energy consumption in the United States, and this percentage is expected to increase as we grow less dependent on non-renewable resources. Ecological impacts of these developments are emerging as a result of increased renewable energy development. Impacts of large-scale solar developments on avian communities have received recent attention. However, little is known about the population-level implications of solar avian fatalities and the context of these fatalities relative to other avian mortality sources. We studied solar avian fatalities in a region of Southern California to present the current state of knowledge about this new source of avian mortality. We also attempted to compare this information from what is known on avian impacts at solar facilities to fatalities at existing wind facilities. As systematic monitoring becomes more prevalent and data more available among solar energy facilities, we may be able to gain a better understanding of the impacts on avian communities. Once we obtain valuable knowledge in this area of research, we can begin to develop successful mitigation measures.

A Thermo-Mechanical Method for Fabrication of Porous Structure for Solar Thermo-Chemical Fuel Production. - Kelvin Randhir, Like Li, Nick AuYeung, Amey Barde, Renwei Mei, David Hahn, James Klausner, University of Florida

Production of synthetic fuels using solar energy is being investigated to improve energy sustainability. The most widely accepted approach is a thermo-chemical route using concentrated solar radiation for two-step water and/or carbon dioxide splitting for production of hydrogen and/or carbon monoxide. The first step is to thermally reduce a reactive oxide to its lower oxidation state followed by the second step in which the reduced oxide is oxidized back to its initial state using steam or carbon dioxide generating hydrogen or carbon monoxide.

A number of materials have been tested for applicability in this process and cerium dioxide has proven to be most effective till date. Some perovskite type materials have also shown promising potential. Regardless of the material that will be selected eventually for large scale implementation, an economical method to produce a stable porous form of the same needs to be developed.

The simplest method that was explored at the University of Florida for fabrication of a porous reactive bed of cerium dioxide was the thermo-mechanical method. Large samples that were compacted in water by sedimentation were sintered at very high temperatures and crushed to an optimum sized particles. Use of this method limits sintering at initial stage and forms a porous skeleton with a stable surface area. The principle behind this method is to form single grain particles which have effectively lower surface energy than the starting loose powders. The inhibition of sintering at initial stage is due to formation of curvatures equal to the final particle curvature at the point of contact.

Porous reactive beds formed using this method has been tested for several redox cycles and showed good stability. The optimum particle size for cerium dioxide heat treated at 1500 °C was found to be 125 µm to 150 µm. However large reactive beds made of such small particles increases the inlet pressure of the system. In order to tackle the large pressure drop and maintain decent reactivity the recommended particle size range is 355 to 1000 µm.

This method can be easily extended to reactive materials like perovskites and other non-stoichiometric compounds which do not undergo structural changes during oxidation-reduction reactions.

Detailed Analysis of Spatially Mapping Solar Cell Parameters - Kortan Ogutman, Kris Davis, University of Central Florida

Atmospheric pressure chemical vapor deposition (APCVD) is a versatile manufacturing process that offers much promise in enabling significant efficiency gains and cost reductions for crystalline silicon (c-Si) solar cells. In this presentation, recent results on the deposition and subsequent processing of functional oxide films using an in-line, high throughput APCVD system will be reported. The materials deposited in this work include aluminum oxide, titanium oxide, silicon oxide, and doped silicon oxide. These oxide films and film stacks can be utilized for doping (e.g., emitter and surface field formation), surface passivation, and photon management on the front and rear side of c-Si solar cells. Experimental data regarding the microstructure, optical properties, and electronic properties of the films will be presented, along with the impact of these films on cell efficiency and other relevant cell parameters. Implications of these results for standard and novel c-Si cell architectures will be covered.

Modeling of Scroll Expanders for Decentralized Power Generation using Solar Energy as Heat Source - Arun Kumar Narasimhan, Rajeev Kamal, Yogi Goswami, Elias K. Stefanakos, University of Florida

Scroll device was invented by a French engineer Léon Creux in 1905, but it was not commercialized until the arrival of CNC machining tools in 1970's. Since then the scroll compressors have been used in commercial HVAC applications, automobiles and turbo superchargers. Recently, scroll compressors have been modified to run as scroll expanders for power generation. They are characterized by low rotational speeds that make them suitable for Organic Rankine Cycles for small-scale power generation. These modified expanders have a volume ratio of about 3, while ORC's require 3-15. This introduces some losses in the expander. Hence, the study aims to develop high-volume-ratio (3-15) scroll expanders for micro-CSP ORC units (~1-25 kW) for decentralized power applications. A scroll device consists of two inter-fitting scrolls, one fixed and the other orbiting that are involutes of a common base circle. The scrolls start from the base circle at an involute initial angle and end at an involute ending angle. The two scrolls are then indexed at 180 from each other resulting in tangential contacts which are called the conjugate or mating points. These mating points form crescent shaped pockets between the two scrolls called chamber volumes. In operation, the superheated and high pressure fluid (from solar field) enters through the suction port at the center. As the orbiting angle increases, the fluid moves to the crescent shaped expansion chambers and with further increase in orbiting angle, opens up to the discharge angle and exits at lower pressure, thereby doing mechanical work which is then converted to electricity. In this work, the authors discuss the design methodology of scroll geometry and the chamber volumes as a function of orbiting angle. The symmetric scroll expander geometry shown below is generated from the following parameters: radius, Rb = 3.26 mm, inner involute initial angle, ϕi0 = 1.4 radians, outer involute initial angle, and ϕo0 = 0 radians and involute ending angle, Fe = 20 radians.

Investigation of Long Term Reactive Stability of Ceria for Use in Solar Thermochemical Cycles - Nathan R. Rhodes, Michael M. Bobek, David W. Hahn, University of Florida

The use of an intermediate reactive material composed of ceria is explored for solar fuel production through a CO2-splitting thermochemical redox cycle. To this end, powder and porous ceria samples are tested with thermogravimetric analysis (TGA) to ascertain their maximum fuel production potential from the CeO2 -> CeO(2-delta) cycle. A maximum value of the non-stoichiometric reduction factor delta of ceria powder was 0.383 at 1450 C. The reactive stability of a synthesized porous ceria sample is then observed with carbon dioxide splitting at 1100 C and thermal reduction at 1450 C. Approximately 86.4% of initial fuel production is retained after 2000 abbreviated cycles, and the mean value of delta is found to be 0.0197. Scanning electron microscopy (SEM) imaging suggests that the porous ceria structure is retained over 2000 cycles despite apparent loss of some surface area. Energy dispersive x-ray spectroscopy (EDS) line scans show that oxidation of porous ceria becomes increasingly homogenous throughout the bulk material over an increasing number of cycles. Significant retention of reactivity and porous structure demonstrates the potential of porous ceria for use in a commercial thermochemical reactor.

High Throughput Processes for PV Module Manufacturing - Vasilios Palekis, S. Collins, V. Evani, M. Khan, C. S. Ferekides, University of South Florida

Cadmium Telluride PV continues to be the lowest cost technology on a $/Watt basis for the manufacturing of PV modules. The highest efficiency reported to-date for a small area CdS/CdTe solar cell of the superstrate configuration is 21%, and for commercial-scale modules 17%. Further reductions in manufacturing costs can be realized through improvements in manufacturing such as increased throughput. This work describes efforts to develop laser-based processes to enable higher throughputs for the manufacture of CdTe PV modules. Localized surface and bulk film heating are being addressed.

The formation of stable, low resistance and non-rectifying contact to p-CdTe is a significant challenge in the fabrication of highly efficient solar cells. Surface preparation techniques including wet etches are typically used to produce a p^+ surface through the formation of a Te-rich layer, followed by the deposition of the metallic contacting material. In this study laser annealing treatment is investigated in order to replace wet treatments for modifying the CdTe surface prior to contact formation. The laser anneals were carried out using a KrF excimer laser at 248nm with a 25ns pulse. CdTe films laser treated (LT) using different incident laser fluences and number pulses. Significant improvements in device performance,elimination of roll-over and increase in Voc and FF, were observed when solar cells were laser treated at 50mJ/cm^2 fluence.

An essential processing step for fabricating high efficiency CdTe/CdS solar cells is the heat treatment (HT) in the presence of $CdCl_2$. The $CdCl_2$ treatment causes significant changes to the films' photovoltaic and structural characteristics including recrystallization resulting in less grain boundary defects and the formation of a shallow acceptor complex, V_{Cd}-Cl_{Te}. This HT also facilitates interdiffusion of CdS and CdTe at the CdTe/CdS junction resulting in reduced interface recombination and therefore better performance. In this study a NIR diode laser operating at 808nm is used for the $CdCl_2$ activation that can significantly reduce the treatment time from 20min (typical HT) to 1-2 minutes and therefore improve throughput in a manufacturing environment. Laser treated devices showed increased carrier collection in the blue and red regions of the spectrum from CdS thinning and S diffusion to CdTe lowering its bandgap. V_{OC}, J_{SC} and FF's improved for laser treated devices when compared to non-treated ones. At higher laser power densities carrier concentration was higher than conventional treated devices. However, this did not result an increase in $V_{OC.}$ The best cell fabricated to-date using a laser-based $CdCl_2$ treatment resulted in an efficiency of 13.25%.

Understanding the Impact of Point Defects on the Performance of Thin Film Solar Cells - Vamsi Evani, M. I. Khan, P. Bane, V. Palekis, S. Collins, C. Ferekides, University of South Florida

Extensive research on Cadmium Telluride (CdTe) based thin film photovoltaic technology over the past two decades has helped laboratory efficiencies reach the 20% mark. Current research is aimed at improving the efficiencies towards the theoretical efficiency limit. Most of the advancement in efficiencies have been brought about by improving the Short Circuit Current (J_{SC}) and Fill Factor (FF) but no significant improvement in Open Circuit Voltage (V_{OC}) was possible. High quality CdTe films with minority carrier lifetimes (beyond 5ns) are necessary to achieve higher V_{OC}'s and therefore higher efficiencies. Native defect concentration which plays a vital role in determining the doping and hence the V_{OC} of CdTe based solar cells, can be altered by controlling the stoichiometry during CdTe growth. Te-rich growth conditions, which favor the formation of point defects responsible for p-type conductivity, also favor formation of defects, which reduce minority carrier lifetime. Therefore, the stoichiometry needs to be precisely controlled in order to improve the doping and also achieve good carrier lifetimes. Conventional deposition techniques do not allow any control of stoichiometry during the growth process. This study investigates a novel deposition technique called Elemental Vapor Transport (EVT) that offers a control of stoichiometry (hence the intrinsic doping) during CdTe growth. CdTe films are deposited from elemental Cd and Te, and the stoichiometry is varied by changing the gas phase ratio of Cd and Te. Such *in situ* control over the concentration of the native defects enables control of intrinsic doping and provides an opportunity for incorporation of extrinsic dopants by creating suitable vacancies. The presentation will discuss the electronic properties of the deposited films and fabricated solar cells as a function of the gas phase Cd to Te ratio during the EVT process. The effect of the deposition process on the properties of films and solar cells is being investigated using techniques such as TRPL, SIMS and TEM.

ENERGY EFFICIENCY (POSTER SESSION)

Anomaly Identification, Detection and Correction on Distribution Networks: a Non-technical Power Loss Study Case - Rodrigo D. Trevizan, Aquiles Rossoni, Arturo S. Bretas, University of Florida

According to OECD statistics, the losses in electric transmission and distribution accounted for about 8% of the total produced energy worldwide in 2014. The great majority of these losses are in distribution networks. In some regions, this value can dramatically increase due to non-technical losses (NTL). The main causes of NTL are electricity theft, frauds in power meters and meter failure. The financial costs caused by these losses harm the entire society, as they are included in the electricity bill, paid by the regular consumers. In addition, the errors in energy meters can lead to imprecise technical losses estimation and gross errors in smart grids measurement systems. In order to mitigate NTL, utilities can perform inspections in clients' electricity meters to detect and correct irregularities. However, performing on-site inspections is costly, therefore inspecting all consumers is not financially feasible. For this reason, methods to detect anomalous clients automatically were proposed in the literature. Some of the most promising techniques of this kind are based on pattern recognition of irregular consumers. In this work, a hybrid method based on the supervised classifier Optimum-Path Forest (OPF) and the Geometrical Approach State Estimator (GSE) is proposed for NTL identification. The GSE is applied to the distribution network using available power measurements and also consumption forecasts, called pseudo measurements. The errors of the GSE are interpreted as the amount of NTL in a given region. This error is then used as an input to the OPF classifier. This classifier uses the information of the errors in a given region along with the monthly consumption record of the customers to identify patterns of consumers where there may be NTL. The classifier is trained using information stored in the utility database, which contains patterns of both normal and irregular consumers where inspections were previously performed. At the end of this process, the classifier shortlists clients who are candidates for inspection. In order to assess the performance of the proposed method, tests are conducted on a database derived from residential consumer data found in the literature and in the IEEE 123-Bus Test Feeder. Two different test cases were analyzed. In the first one, the NTL are concentrated at some transformers in one region of the test feeder, while in the second one, the NTL are spread throughout the feeder. Those assumptions are based on some references which state that there is a high correlation between location and NTL. The results show that the mean performance of the OPF classifier can improve from 53.18% to 72.43% of customers correctly identified as having NTL for the first case when the hybrid method was used instead of standard OPF. For the second condition, the performance increased from 46.97% to 57.51%. The results show that a hybrid approach between heuristic methods, such as the OPF classifier, and state estimation can result in a more efficient method for NTL location. Therefore, implementing such a system can help electric utilities improve their economic performance by reducing NTL.

Integration of Technologies for Recovery of Energy and Nutrients from Dairy Wastes - Shunchang Yang, Pratap Pullammanappallil, University of Florida

Livestock operations are a major cause of pollution of water resources. Nitrogen (N) and Phosphorus (P) contamination of lakes and river systems in Florida have been attributed in some cases to run-offs from dairy operations. Currently manure from most dairies is land applied supplying the nutrient and water for crop growth. The extent to which manure can be applied is restricted through regulations based on N and P loadings per unit area of land. Consequently large farm areas are required to dispose dairy manure. Also there are concerns associated with pathogen and odors from manure. With the rising, global demand of fertilizers; technologies for recovering N and P nutrients from wastewater is gaining more attention.

Anaerobic digestion (AD) is a biochemical process that mineralizes organic compounds to a gaseous biofuel called biogas containing 60% methane. This process has been traditionally applied for waste management as it not only produces a fuel but also reduces the organic pollutant content of the waste stream. Anaerobic digestion can also mitigate the odor and pathogen problem associated with waste streams. Dairy manure (DM) is a good candidate for anaerobic digestion and several digesters have been set up to treat manure. Nitrogen and phosphorous compounds like ammonia and phosphate are conserved during anaerobic digestion if not mobilized from nitrogen and phosphorous containing organic compounds. The effluent from an anaerobic digester is an ideal stream to recover phosphate. Phosphorous can be recovered in the form of a mineral called struvite (MgNH4PO4•6H2O). Some amount of ammonium is also removed in this manner. Struvite precipitation and its recovery is affected by pH, molar ratios of magnesium, ammonium and phosphate, and mixing regimes.

In this paper we will present the performance of a pilot scale Induced Blanket Reactor (IBR) anaerobic digester treating manure from both flushed and scrapped dairies. The performance of the reactor was measured in terms of loading rate, hydraulic retention time, biogas production, biogas composition, pH, and volatile organic acid concentration. The effluent from IBR was then processed for struvite recovery. The struvite precipitation process was simulated by MinTeq software to optimize the pH and amount of magnesium loaded. The struvite recovery process was implemented in a lab scale apparatus. Experiments were conducted using both raw and anaerobically digested effluent to quantify the extent of phosphate and ammonia removal through struvite recovery. The integration of struvite recovery with anaerobic digestion results in an effluent that is lower not only in organic content but also phosphate coupled with energy recovery.

An Experimental Investigation of Occupancy-Based Control of Commercial Building Climate - <u>Jonathan Brooks</u>, Siddharth Goyal, Rahul Subramany, Yashen Lin, Timothy Middelkoop, Prabir Barooah, University of Florida

We present results from a week-long experimental evaluation of a scalable control algorithm for a commercial building heating, ventilation, and air-conditioning (HVAC) system that was proposed in our earlier work. Most commercial buildings' HVAC systems are inefficient because they use daily operation schedules without knowledge of actual occupancy. This can adversely affect occupant comfort if, for example, an occupant is present in the building after-hours. Similarly, this can waste energy if a room is being fully conditioned when it is empty. The control algorithm tested here changes temperature set points based on real-time occupancy measurements to save energy. The experiments showed that the proposed controller resulted in 37% energy savings over baseline without sacrificing indoor climate. In contrast to prior work that reports energy savings without a careful measure of the effect on indoor climate, we verify that the controller indeed maintains indoor climate just as well as the building's baseline controller from measurements of a host of environmental variables and analysis of before-after occupant survey results.

SMART-GRID & STORAGE (POSTER SESSION)

Distributed Optimization-based Load Control in a Power Grid for Primary Frequency Response while Minimizing Consumer Disutility - Jonathan Brooks, Prabir Barooah, University of Florida

A key aspect of the power grid is that power generated must equal power demanded. If this condition is not met, generators may be damaged, and blackouts may ensue. Traditionally, when generation and demand become unbalanced, different generators throughout the grid adjust their generation. This ramping is often less efficient for generators while also increasing emissions. Increased penetration of volatile renewable energy sources poses new challenges for maintaining the balance between generation and demand. If generators are used in the same traditional capacity, fleets of new fossil-fuel generators will be needed as backups to mitigate the renewable energies' volatility, which may offset the benefits of renewable energies themselves. Controllable loads offer a great resource to maintain this balance. Instead of generators adjusting generation, loads can adjust demand, which does not affect emissions, but the impact on consumers must be minimized. One way for loads to provide this service to the grid is for loads to track a reference signal broadcast by a central balancing authority. In previous work, our group has shown through experiments conducted on the University of Florida campus that fans in a commercial building's HVAC system can track such reference signals well. This requires communication between each load and the central balancing authority, however, which may not be practical for all loads. Another approach is for loads to use local information to make decisions. We have developed a distributed load-control algorithm in which every load varies its consumption based on local frequency measurements and communication with only nearby loads so that consumption and generation are equalized in the whole grid--thereby reducing system frequency deviations from the nominal operating point--while minimizing its own disutility that results from varying consumption. All loads collectively step to decrease total disutility at each iteration by adjusting consumption individually such that total consumption is unaffected. Simultaneously, each load additionally increases or decreases consumption to balance generation and total consumption. This is done in a distributed manner that preserves communication constraints among loads.

Smart and Flexible Resources to Harness Solar Power in Florida - D. Surya Chandan, A. S. Bretas, Sean Meyn, Prabir Barooah, University of Florida

Power Quality (PQ) is an important characteristic of electric power systems. The growing concern about climate changes and the perennial oil crisis has piqued the interest in Distributed Generation (DG), which in turn poses new challenges in power quality management. The index of PQ in this paper is "variation in voltage magnitude".

Distributed generation (DG) is viewed as a potential threat to power quality, which is the likely motivation for the IEEE 1547 Standard: "DG shall not actively regulate the voltage and shall not cause the system voltage to go outside the requirements of ANSI C84-1, Range A (95% to 105%)." That is, this standard mandates that DG such as distributed solar operate with fixed power factor (unity PF). This policy ignores the potential value of power electronics connected to DG that could be harnessed to regulate voltage and reactive power. The thesis of this research is that there is a need to de-rate the inverters and make them "Smart" to provide reactive power control.

The intermittent nature of the DG can cause power fluctuation and voltage flicker. Voltage regulation under these conditions is an imperative technical challenge. We also advocate incentives for DG's to de-rate their inverters to overcome this challenge.

We propose a control strategy in which there is communication between the distribution control center in a region and equipment on the distribution network to achieve a flat voltage profile with increased DG. The control of several resources is performed in unison: in addition to controllable inverters, power consumption from flexible loads can be modulated to regulate real power in conjunction with batteries. The control problem is formulated as an optimization problem, in which power quality is optimized, subject to constraints on quality of service to each load. The optimal solution determines the configuration of capacitor banks, batteries, power consumption of flexible loads, and the power injection from the DG's.

In addition to power quality, the cost function in this optimization problem will take into account stress on equipment and systems technical power losses. For example, the control solution will reduce the number of automatic tap changes of an on-load distribution transformer and technical power losses in a line. This will reduce the payback period on the capital invested for infrastructure.

Simulations are performed using a statistical model based on observed solar generation profiles in the state of Florida. We use the appropriate load profile for various loads. We perform power flow analysis of the feeder by applying the Modified Ladder Iterative technique. The solution determines the voltage magnitudes at all nodes, active power of flexible load, total feeder input, line flow and power loss in each line section (KW). We simulate the extreme conditions by considering a highly volatile profile for solar radiation on a cloudy day and by turning a heavy load on and off.

Test results show that with appropriate design of control strategies and communication infrastructure, power quality and reliability can be maintained even with increased penetration of DG.

Solar-Driven Photo-Thermochemical Water-Splitting Cycle with Integrated Thermal Energy Storage - Nazim Muradov, Ali T-Raissi, Nan Qin, University of Central Florida – Florida Solar Energy Center

Solar water-splitting thermochemical cycles (WSC) constitute the ultimate option for hydrogen production since this pathway does not require any fossil fuels. WSC can achieve overall energy (solar-to-H2) conversion efficiencies of 40% and higher (compared to 28-32% for advanced electrolysis). There have been more than 300 WSCs conceived for water splitting of which, only less than a dozen or so are still being researched worldwide. The main limitations of the existing solar-powered WSC are that they (i) utilize only thermal (IR) component of the solar irradiation (neglecting quantum component), (ii) do not take into consideration the intermittent nature of the solar resource, and (iii) involve technically-challenging reagents transport and separation stages. FSEC researchers have developed a new family of hybrid sulfur–ammonia (S-A) photo-thermochemical WSC that circumvent the above shortcomings. S-A cycles through the means of solar beam-splitting utilize the quantum (UV-Vis) and the thermal (IR) portions of the solar spectrum for hydrogen and oxygen production, respectively, as represented by the following generic equations:

1. $SO_2 + 2NH_3 + H_2O \rightarrow (NH_4)_2SO_3$ (chemical absorption) 25°C
2. $(NH_4)_2SO_3 + H_2O \rightarrow (NH_4)_2SO_4 + H_2$ (solar UV-Vis photocatalytic) 20-80°C
3. $(NH_4)_2SO_4 + MO \rightarrow 2NH_3 + MSO_4 + H_2O$ (solar IR thermal) 400-500°C
4. $MSO_4 \rightarrow MO + SO_2 + 1/2O_2$ (solar IR thermocatalytic) 850-950°C

Where MO is alkali metal sulfate (e.g., Na_2SO_4, K_2SO_4, Rb_2SO_4). The step (1) is a simple chemical absorption process taking place at near ambient conditions. In the photocatalytic step (2) hydrogen production is accomplished using narrow band gap photocatalysts (e.g., CdS). Of particular interest are binary photocatalysts based on the combination of two semiconductors with suitable band gaps (e.g., CdS-ZnS, CdS-NiS, CdS-MoS_2, and others). The reaction (3), in the case of MO=K_2SO_4, results in the production of $K_2S_2O_7$ molten salt, which can be pumped through pipes as liquid, thus, simplifying materials transport and handling. Another advantage of the new cycle is that it provides integrated (or in situ) thermal storage and energy recovery by means of the molten salt $K_2S_2O_7$-based system as integral part of WSC. The overall photon conversion efficiency was estimated at 25.3%.

POSTER LISTING

WEDNESDAY

POSTER SESSION I: Poster Set-up - 7:00-8:30am; Poster Session I – 12:25-1:00pm

Track 1: Renewable/Alternative Power and Storage		Track 2: Education	
Poster #	**Title/ Presenter Name**	**Poster #**	**Title/ Presenter Name**
1.	*What's "Current" in Ocean Energy – Camille E. Coley, Florida Atlantic University*	**14.**	*Solar Energy Technologies: Fundamentals and Applications in Buildings - Cheng-Xian Lin, Florida International University*
2.	*Natural Gas: A Pathway to Low Carbon Motor Fuels - David E. Bruderly PE, Bruderly Engineering Associates, Inc.*	**15.**	*Buildings and Energy: Design and Operation vs. Sustainability: an Energy Engineering Course for Florida-specific Building Design & Operation - Prabir Barooah, Duzgun Agdas, Ravi Srinivasan, University of Florida*
3.	*Selective Non-Catalytic Reduction (SNCR) in a Diesel Engine - John Nuszkowski, David Armstrong, Samantha Delgado, Matt Furlong, Alex Knapp, C. Reid Shore, University of North Florida*	**16.**	*Renewable Energy Courses for Master's in Global Sustainability - George Philippidis, University of South Florida/Patel College of Global Sustainability*
4.	*Security-Constrained Unit Commitment with Dynamic Ratings – Anna Danandeh, Bo Zeng, Brian Buckley, University of South Florida*	**17.**	*Renewable Energies and Sustainability Education – Ryan Integlia, Sesha Srinivasan, Gary Albarelli, Brian Birky, Jorge Vergas, Jaspreet Dhau, Ghazi Darkazalli, Florida Polytechnic University*
5.	*General Capacitor's High Energy Li-ion Capacitors - Jim P. Zheng and Wanjun Cao, FAMU-FSU College of Engineering*	**18.**	*Cultivating Change: Using Social Marketing to Encourage Environmental Behaviors - Laura A. Warner, Kathryn A. Stofer, University of Florida*
6.	*Optimization of LiMnPO4 Using Solid State Processes – Charles Oladimeji, P.L. Moss, FAMU-FSU College of Engineering*	**19.**	*Educating on Economic Realities of Sustainable Energy – Michelle Phillips, Mark Jamison, PURC*
7.	*Hydrogen Energy Storage for On-Board Fuel Cells, Concentrated Solar Power and Secondary Batteries – Sesha Srinivasan, Ryan Integlia, Jaspreet Dhau, Jorge Vargas, Florida Polytechnic University*	**20.**	*Educational Modules in Support of Sustainable Energy Courses - J.C. Ordonez, Sam Yang, M.B. Chagas, K. Ribeiro, C. Ordonez, T. Solano, J.V.C. Vargas, H. Li, Energy and Sustainability Center*
8.	*Flywheel Energy Storage for Rural Residential Applications Supplied by Intermittent Wind Power - Ahmed Elsayed, Tarek Youssef, Osama Mohammed, Florida International University*	**21.**	*Matching Training to Industry Needs - Nina Stokes, Marilyn Barger, Richard Gilbert, FLATE*
9.	*Quest for Grid Energy Storage: Case for the Performance of Iron-Ion/Hydrogen Redox Flow Battery Mixed Electrolytes - Venroy Watson, Derrick Nguyen, Edward E. Effiong, Egwu E. Kalu, Florida A & M University*	**22.**	*The University of Florida Training Reactor: Powering Nuclear Education & Innovation - Shannon L. Eggers, Kelly A. Jordan, University of Florida*
10.	*Economic Performance of Thermal Energy Storage Integrated with Natural Gas Combined Cycle Power Plants - Barry Osterman-Burgess, Yogi Goswami, Elias Stefanakos, University of South Florida/CERC*	**23.**	*Save Money: Be a Savvy Consumer of Energy - Heidi Copeland, Will Sheftall, Bob Seaton, University of Florida/IFAS Extension*
11.	*FAMU Spheromak: Fusion Energy for Distributed Energy Resources - Jerry Clark, Charles A. Weatherford, Ronald Williams - Florida A&M University*	**24.**	*Developing Leaders for a Sustainable Future - Linda Seals, Holly Abeels, Gayle Whitworth, University of Florida/IFAS Extension Brevard County*
12.	*Renewable Cities: Technology, Goals, and Implementation - Santiago Arias, Darren Brandes, Christopher Brown, Caroline Mayer, Fazil T. Najafi, University of Florida*		
13.	*A Systems Engineering Model for Harvesting Electricity From Shallow Water Tidal Currents - John Domenech, Tim Eveleigh, George Washington University*		

FESC Florida Energy Systems Consortium

WEDNESDAY

POSTER SESSION II: Poster Set-up - 1:00-2:30pm; Poster Session II – 4:40-5:20pm

Track 1: Biomass		Track 2: Solar Energy	
Poster #	**Title/ Presenter Name**	**Poster #**	**Title/ Presenter Name**
1.	*Development and Scale-Up of a Horizontal Bioreactor for High-Density Cultivation of Microalgae - Ioannis Dogaris, Michael Welch, Bethany Loya, Andreas Meiser, Lawrence Walmsley, George Philippidis University of South Florida*	**11.**	*An Analysis Between the State of Solar Energy Development in Europe and the United States - Mary Kate Fitzgerald, Gage Vincent, Estelle Wilson, Pan Xu, Nicholas Yonezawa, Fazil T. Najafi, University of Florida*
2.	*Cultivation and Optimization of Saline Microalgae BG0011 for Production of Biofuels and Bioproducts - Yingxiu Zhang, Tung Chen, Vincent Ferrone, Cesar M Moreira, Spyros Svoronos, Edward Phlips, Pratap Pullammanappallil, University of Florida*	**12.**	*Advancing Solar – Susan Glickman, Southern Alliance for Clean Energy*
3.	*Introducing a Membrane Photobioreactor for Cultivating Microalgal Biofuels in Wastewater - Ivy Drexler, M Pickett, DH Yeh, University of South Florida*	**13.**	*The Integration of Solar Power as a Renewable Source of Energy in the United States - Patricia Cruz, Doug Hinton, Dorian Johnson, Cara Keller, Giuseppe Zuozo, Fazil T. Najafi, University of Florida*
4.	*Industrial Sweetpotato and Energybeet Potential for Biofuel Feedstocks in South Florida - Brian Boman, Edward Evans, Ann Wilkie, Janie Ryan-Bohac, University of Florida/Indian River REC*	**14.**	*Conducting Polymer-Dye Composites for Photoelectrochemical Solar Cells and Energy Storage - Arash Takshi, University of South Florida*
5.	*Evaluating the Bioenergy Potential of Sweetpotato Vines - Wendy A. Mussoline, Ann C. Wilkie, University of Florida/IFAS Extension*	**15.**	*Atmospheric Pressure Chemical Vapor Deposition of Functional Oxide Materials for Crystalline Silicon Solar Cells - Kristopher O. Davis, Winston V. Schoenfeld, University of Central Florida/FSEC*
6.	*Florida Farm to Fly: Advanced Biofuel Feedstock Supply Chain Integration - Ben DeVries, Treasure Coast Research Park*	**16.**	*Establishing Field Equivalents of Accelerated Tests for Bypass Diodes in PV Modules – Narendra Shiradkar, Vivek Gade, Kalpathy Sundaram, Winston Schoenfeld, University of Central Florida*
7.	*Reinvigorating Oleoresin Collection in the Southeastern USA: Evaluation of Stand Management and Tree Characteristics with Borehole Tapping - J. Lauture, Gary Peter, A. Hodges, University of Florida*	**17.**	*Factors in the Formation of Cracks in Mono-Crystalline Silicon Solar Cells - Hubert Seigneur, Narendra Shiradkar, University of Central Florida*
8.	*An Intensified Process for Production of Liquid Hydrocarbon Fuels From Biogas to Overcome BGTL Economy of Scale Challenges - Nada Elsayed, Babu Jospeh, John Kuhn, University of South Florida*	**18.**	*Nanoscale Interfaces in Energy Application - Luping Li, Cheng Xu, Kirk J. Ziegler, University of Florida*
9.	*Adaptation of Mesophilic and Thermophilic Anaerobic Digester to Saline Conditions - Doan, Nguyet, Cabrol, L., Moreira, C., Tapia, E., Svoronos, S. A., Phlips, E., Ruiz-Filippi, G., Pullammanappallil, P.C., University of Florida*	**19.**	*Recent Advances in Polymer Solar Cells - Ifedayo Ogundana, Simon Y. Foo, Zhibin Yu, Indranil Bhattacharya, Florida State University*
10.	*Novel Biocatalylic Process for Biodiesel Production - Huali Wang, Brent Chrabas, Viesel Fuel LLC.*	**20.**	*Smart Solar Electric Vehicle Technology - Ashly Locke, Ryan Integlia, Sesha Srinivasan, Jorge Vergas, Jaspreet Dhau, James Mulharan, Eric Vickers, Florida Polytechnic University*
		21.	*Performance Analysis of C-Si Module Deployed at FSEC After 10 Years Exposure - Eric Schneller, Joe Walters, Stephen Barkaszi, Kris Davis, Winston Schoenfeld, University of Central Florida*
		22.	*Solar Thermochemical Fuel Production at the University of Florida - Jonathan R. Scheffe, David W. Hahn, Renwei Mei, University of Florida*
		23.	*High Efficiency Thermochemical Fuel Production Using the UF 10 kW Solar Reactor - Kelvin Randhir, Like Li, Nick AuYeung, Amey Barde, Benjamin Greek, Nathan Rhodes, Renwei Mei, David Hahn, James Klausner, University of Florida*
		24.	*The Costs and Benefits of Solar Road Technology - Courtnay Cardozo, Juan Camargo, Kyle Findlater, Josh Herrera, Fazil T. Najafi, University of Florida*

FESC Florida Energy Systems Consortium

WEDNESDAY

ADDITIONAL POSTER SESSION: 5:20pm – Poster Set-up; 5:25-5:55pm – Additional Poster Session

Track 1: Renewable/Alternative Power and Storage

Poster #	Title/ Presenter Name
1.	*Sustainability in Rapid Prototyping - Joseph Prine, John McCormack, Jorge Vargas, Jaspreet Dhau, Sesha Srinivasan, Ryan Integlia, Florida Polytechnic University*

Track 2: Biomass

Poster #	Title/ Presenter Name
2.	*Dual Purpose Benefits of the Sweetpotato Crop: Biofuel and Animal Feed - Lara R. Nesralla, Wendy A. Mussoline, Ann C. Wilkie, University of Florida/IFAS*
3.	*Cultivation of Filamentous Algae for Bioenergy Production - Kimberly D. Hafner, Ann C. Wilkie, University of Florida*
4.	*Impact of Phytohormones on Microalgal Growth and Lipid Content - Brett S. Nelson, Ann C. Wilkie, University of Florida*
5.	*Techno-Economic Analysis of Bioethanol Production From Lignocellulosic Biomass: Process Integration with Energy Recovery From Wastes - Na Wu, Pratap Pullammanappallil, University of Florida*
6.	*Synthesis of Biodiesel via Supercritical Transesterification Route from Waste Cooking Oil - Z. Cerniga, Shriyash Deshpande, D. Townsend, K. Cogswell; A. Driscoll, A. Sunol, G. Philippidis, M. Pandey, University of South Florida*

Track 3: Solar Energy

Poster #	Title/ Presenter Name
7.	*Avian Mortality at Solar Energy Facilities in Southern California - Stephanie Meyers, Lee Walston, University of Illinois at Urbana–Champaign*
8.	*A Thermo-Mechanical Method for Fabrication of Porous Structure for Solar Thermo-Chemical Fuel Production - Kelvin Randhir, Like Li, Nick AuYeung, Amey Barde, Renwei Mei, David Hahn, James Klausner, University of Florida*
9.	*Detailed Analysis of Spatially Mapping Solar Cell Parameters - Kortan Ogutman, Kris Davis, University of Central Florida*
10.	*Modeling of Scroll Expanders for Decentralized Power Generation using Solar Energy as Heat Source - Arun Kumar Narasimhan, Rajeev Kamal, Yogi Goswami, Elias K. Stefanakos, University of South Florida*
11.	*Investigation of Long Term Reactive Stability of Ceria for Use in Solar Thermochemical Cycles - Nathan R. Rhodes, Michael M. Bobek, David W. Hahn, University of Florida*
12.	*High Throughput Processes for PV Module Manufacturing - Vasilios Palekis, S. Collins, V. Evani, M. Khan, C. S. Ferekides, University of South Florida*
13.	*Understanding the Impact of Point Defects on the Performance of Thin Film Solar Cells – Vamsi Evani, M. I. Khan, P. Bane, V. Palekis, S. Collins, C. Ferekides, University of South Florida*

Track 4: Energy Efficiency

Poster #	Title/ Presenter Name
14.	*Anomaly Identification, Detection and Correction on Distribution Networks: a Non-technical Power Loss Study Case - Rodrigo D. Trevizan, Aquiles Rossoni, Arturo S. Bretas, University of Florida*
15.	*Integration of Technologies for Recovery of Energy and Nutrients from Dairy Wastes – Shunchang Yang, University of Florida*
16.	*An Experimental Investigation of Occupancy-Based Control of Commercial Building Climate - Jonathan Brooks, Siddharth Goyal, Rahul Subramany, Yashen Lin, Timothy Middelkoop, Prabir Barooah, University of Florida*

Track 5: Smart Grid and Energy Storage

Poster #	Title/ Presenter Name
17.	*Distributed Optimization-based Load Control in a Power Grid for Primary Frequency Response while Minimizing Consumer Disutility - Jonathan Brooks, Prabir Barooah, University of Florida*
18.	*Smart And Flexible Resources to Harness Solar Power in Florida - D. Surya Chandan, A. S. Bretas, Sean Meyn, Prabir Barooah, University of Florida*
19.	*Solar-Driven Photo-Thermochemical Water-Splitting Cycle with Integrated Thermal Energy Storage - Nazim Muradov, Ali T-Raissi, Nan Qin, University of Central Florida/FSEC*

FESC Florida Energy Systems Consortium

THURSDAY

POSTER SESSION III: Poster Set-up – 7:00-8:30am; Poster Session III – 11:25-11:55am

Track 1: Energy Efficiency		Track 2: Smart Grid and Energy Storage	
Poster #	**Title/ Presenter Name**	**Poster #**	**Title/ Presenter Name**
1.	*Boosting Efficiency in Buildings - Chris Castro, Jonathan Ippel, City of Orlando*	**16.**	*Dispatchable Micro-CHP and Micro-CCHP - Stephen Welty, Calor Technologies*
2.	*High Efficiency Multi-Family Housing Renovations at UF's Corry Village - Craig Miller, Bahar Armaghani, Steve Wargo, University of Florida Program for Resource Efficient Communities*	**17.**	*A New Way Forward for Energy Companies: Cloud & Mobile Technologies - Ben Amaba, Ph.D., Professional Engineer, CPIM®, LEED® AP BD+C, IBM*
3.	*Efficiency of Florida's Affordable Multifamily Housing: Diving Deeper into Consumption, Property, and Tenant Characteristics Data - Nicholas Taylor, Anne Ray, Jennison Searcy, Lesly Jerome, University of Florida Program for Resource Efficient Communities*	**18.**	*eNOS - An Open Source Energy OS - Raymond Kaiser, Amzur Technologies*
4.	*Multifamily Energy-Efficiency Retrofit Programs: A Florida Case Study - Nicholas Taylor, Jennison Searcy, Pierce Jones, University of Florida*	**19.**	*High Impedance Fault Detection on Distribution Networks: an Adaptive Approach Considering a Noisy Environment - Arturo Bretas, Leonardo Lurinic, Renato Ferraz, University of Florida*
5.	*Design of Incentive Programs to Promote Net Zero Energy Buildings - Alireza Ghalebani, Tapas K Das, University of South Florida*	**20.**	*Smart Fridge / Dumb Grid : Architecture for the Electricity Network of 2020 - Y. Chen, J. Ehren, R. Kaddah, J. Mathias, P. Barooah, A. Busic, Sean Meyn, University of Florida*
6.	*Experimental Exergy Analysis of an Off-Grid Zero Emissions Building - Sam Yang, M. Chagas, J.C. Ordonez, J.V.C. Vargas, C. Ordonez, Florida State University*	**21.**	*Develop Smart Power Inverters to Improve the Performance of Smart Power Grid - Shuo Wang, University of Florida*
7.	*Optimization of Chilled Water Plant Operation using Modelica Buildings Library - Sen Huang, Wangda Zuo, University of Miami*	**22.**	*Home Is Where the Heart Is: Complexity, Pattern, and Meaning in Short Interval Residential Electric Smart Meter Data – Hal Knowles, University of Florida/PREC*
8.	*Transportation Energy and Space Technology Hub (TEST Hub) at NASA Kennedy Space Center - Advanced Transit Technology Demonstration Projects: Dual-Fuel Fuel Cell Demonstration and Thermo Electric Generation Transit Bus Demonstration - David Teek, Tim Franta, Mike Aller, Energy Florida*	**23.**	*Fault Location Identification in Smart Distribution Networks with Distributed Generation - Jose Cordova, Omar Faruque, Florida State University*
9.	*Ducted Heat Pump Water Heater Cooling and Heating Performance in Florida - Carlos Colon, Eric Martin, Danny Parker, University of Central Florida/ FSEC*	**24.**	*Real-Time Digital Simulation Based SCADA Lab and HIL Machine Drive Lab at USF - Hossein Ghassempour Aghamolk, Zhixin Miao, Lingling Fan, University of South Florida*
10.	*Greenstar Roof Insulation: Heat Evicting Innovation – Paul White, Greenstar Panels*	**25.**	*Nickel Iron Batteries for Twenty First Century Energy Storage - David Atherton, Randy Ogg, Encell Technologies*
11.	*Planning for Urban Sustainability: Comparing the Impacts of Residential Design Alternatives - Lynn M. Jarrett, Hal S. Knowles III, Barbra C. Larson, University of Florida/Program for Resource Efficient Communities*	**26.**	*G4 Synergetics High Power Battery - Mark Kohler, G4 Synergetics, Inc.*
12.	*Performance and Energy Efficiency Analysis of Join Algorithms on GPUs - Ran Rui, Hao Li, Yicheng Tu, University of South Florida*	**27.**	*The Impact of Double-use Storage on a Grid Connected House with Photovoltaics - Richard Aarons, Omonayo Bolufawi, Mark H. Weatherspoon, Florida A & M University*
13.	*Smart Meter Data Analytics – Using Data for Energy Efficiency, Kevin Burns, Orlando Utilities Commission*	**28.**	*Analysis of Coupling Dynamics for Power Systems with Iterative Discrete Decision Making Architectures - Zhixin Miao, University of South Florida*
14.	*Dynamic Power-Aware Disk Storage Management in Database Servers - Peyman Behzadnia, Yicheng Tu, University of South Florida*	**29.**	*Modeling of Packed Bed Thermal Energy Storage with Encapsulated Phase Change Material - Francesca Moloney, University of South Florida*
15.	*Dynamically Controlled Smart Walls – The New Standard for Home and Building Construction - Justin Zhou, Julius Regalado, IVy Composites, Inc. (Poster Only)*		

Prefix	First Name	Last Name	Title	Phone	Email	Company
	Richard	Aarons		(850) 227-8569	aaronri@eng.fsu.edu	
Dr.	Ben	Amaba	Worldwide Executive	(305) 495-7953 (305) 495-7953	baamaba@us.ibm.com	Ibm
Dr.	David	Atherton	Principal Scientist	3 2310216	datherton@encell.com	Encell Technology
Ms.	Meera	Bagati			meera.bagati@nexteraenergy.com	
Mrs.	Canan	Balaban	Associate Director	(352) 392-0899	cbalaban@ufl.edu	FESC
Ms.	Ann	Beckwith	Green Energy & Regulatory Specialist	(321) 239-1008	ann.beckwith@fmpa.com	Florida Municipal Power Agency
Dr.	Richard	Behr	Dean - U.A. Whitaker College of Engineering	(239) 590-7390	lsee@fgcu.edu	Florida Gulf Coast University
Dr.	Brian	Boman	Professor	(772) 468-3922 ext. 122	bjbo@ufl.edu	University of Florida, Indian River Rec
Mr.	Tommy	Boroughs	Partner	(407) 244-5132	tommy.boroughs@hklaw.com	Holland Knight, LLP
Mr.	Mauricio	Braun Chagas			mb14s@my.fsu.edu	Florida State University
Prof.	Arturo	Bretas	Professor	(352) 392-4949	arturo@ece.ufl.edu	University of Florida
Prof.	Denise	Bristol	Faculty - Biological & Environmental Sciences	(813) 253-7000 ext. 5034	dbristol@hccfl.edu	Hillsborough Community College
Mr.	Jonathan	Brooks		(407) 617-5105	brooks666@ufl.edu	University of Florida
Mr.	David	Bruderly	President	(352) 281-2696	bruderly@aol.com	Bruderly Engineering Associates, Inc.
Dr.	Beth	Burch	Bioenergy Program, Lead Instructor	(863) 784-7230 (863) 784-7230	beth.burch@southflorida.edu	South Florida State College
	Kevin	Burns	Manager, Conservation	(407) 434-2248	kburns@ouc.com	Orlando Utilities Commission
Mr.	Sarmad	Chaudhry		(954) 397-2332	s.chaudhry.7@ufl.edu	University of Florida
Ms.	Maddy	Chokshi	Research Development Coordinator	(407) 882-1141	mchokshi@ucf.edu	University of Central Florida
	Camille	Coley			ccoley@fau.edu	
Mr.	Carlos	Colon	Sr. Research Engineer	(321) 638-1435	carlos@fsec.ucf.edu	Florida Solar Energy Center
	Heidi	Copeland	Fcs Extension Agent	(850) 606-5229	copelandhe@leoncountyfl.gov	Uf/ifas Extension
Mr.	Jose	Cordova	Graduate Student	(859) 285-9223	jdc13b@my.fsu.edu	Florida State University
Ms.	Margaret	Cullen	Trade Commissioner	(305) 579-1612	margaret.cullen@international.gc.ca	Consulate General of Canada
	Jenna	Curtis	Student	(352) 392-8699	curtisjenna@ufl.edu	University of Florida-Ifas
Prof.	Jennifer	Curtis	Associate Dean for Research	(352) 392-0946	jcurtis@eng.ufl.edu	University of Florida
Dr.	Kristopher	Davis	Research Engineer	(407) 823-6149	kdavis@fsec.ucf.edu	University of Central Florida
Mr.	Shriyash	Deshpande	Graduate Research Assistant	(225) 252-9178	shriyash@mail.usf.edu	University of South Florida
Mr.	Ben	DeVries	CEO & Executive Director	(772) 467-3107	ceo@tcerda.org	Treasure Coast Research Park
Mr.	Surya Chandan	Dhulipala	Student	(813) 451-7735	chandandhulipala@ufl.edu	University of Florida
Ms.	Nguyet	Doan	PhD student	(352) 999-1886	dtmnguyet@ufl.edu	University of Florida
Dr.	Ioannis	Dogaris	Postdoctoral Scholar		idogaris@usf.edu	University of South Florida
Mr.	John	Domenech	PhD Candidate		johndomenech@gwmail.gwu.edu	The George Washington University
	Cabbar	Dundar	Student	(352) 392-8699	cdundar@ufl.edu	University of Florida-Ifas
Ms.	Shannon	Eggers	Student	(352) 363-0280	seggers99@ufl.edu	University of Florida
	Nada	Elsayed	Student	(813) 810-0130	nelsaye2@mail.usf.edu	University of South Florida
Dr.	Omar	Faruque	Assistant Professor	(850) 645-8971	faruque@caps.fsu.edu	Florida State University
	Jim	Fenton			jfenton@fsec.ucf.edu	
Mrs.	Trish	Fields	Senior Director, State Partnerships and Strategic Engagement	(781) 738-0820	tfields@aee.net	Advanced Energy Economy
Dr.	Simon	Foo	Professor and Chair	(850) 410-6474	sfoo@fsu.edu	FAMU-FSU College of Engineering
Dr.	Brent	Gila	Director	(352) 273-2245	bgila@ufl.edu	UF-NRF Research Service Center
Prof.	Ramon	Gonzalez	Professor & Director	(713) 348-4893	ramon.gonzalez@rice.edu	Rice University
Dr.	Rodney	Guico	Director of Industry Programs	(352) 392-8049 ext. 1006	rguico@eng.ufl.edu	College of Engineering, University of Florida
	Kimberly	Hafner	Student	(352) 392-8699	hafnerk@ufl.edu	University of Florida-Ifas
Mr.	Dan	Holladay	Managing Director	(407) 742-4252	dan.holladay@ucf.edu	International Consortium for Advanced Manufacturing Research
Dr.	Lynne	Holt	Policy Analyst	(352) 271-0854	lynne.holt@warrington.ufl.edu	Public Utility Research Center
Prof.	Marija	Ilic	Professor	(412) 268-9520	milic@ece.cmu.edu	Carnegie Mellon University
Mr.	Terrill	Jackson	Undergraduate Assitant	(954) 607-8189	tjackson@fsec.ucf.edu	Florida Solar Energy Center
Ms.	Lynn	Jarrett	Water Resources Engineer	(352) 273-0246	ljarrett@ufl.edu	University of Florida / Prec
	Gary	Jones	Student	(352) 392-8699	jonegn1@ufl.edu	University of Florida-Ifas
Mr.	Raymond	Kaiser	Director Energy Management Systems	(813) 600-4060 ext. 130	raymond.kaiser@amzur.com	Amzur Technologies
Dr.	John	Kantner	Assoc. VP for Research, Dean Graduate School	(904) 620-4650	j.kantner@unf.edu	University of North Florida
Mr.	Byron	Knibbs	Vice President, Customer & Sustainable Services	(407) 434-2194	bknibbs@ouc.com	Orlando Utilities Commission
Mr.	Hal	Knowles	PhD Candidate & Change Agent	(352) 273-0239	hknowles@ufl.edu	UF Program for Resource Efficient Communities
Mr.	Mark	Kohler	Program Manger	(352) 462-9532 ext. 123	mark.kohler@g4sinc.com	G4 Synergetics, Inc.
Mr.	Stu	Lamb	CEO	772 781 ext. 4300	stulamb@vieselfuel.com	Viesel Fuel, LLC
	Gage	Lapierre	Student	(352) 392-8699	gagemo@ufl.edu	University of Florida-Ifas
Mr.	Tom	Lawery	Renewables / Wholesale Manager	(727) 460-9878	thomas.lawery@duke-energy.com	Duke Energy
Mr.	John	Leeds	Analyst	(850) 617-7470	john.leeds@freshfromflorida.com	FDACS, Office of Energy

Prefix	First Name	Last Name	Title	Phone	Email	Company
Dr.	Like	Li	Postdoc Associate	(352) 328-2963	likelichina@ufl.edu	University of Florida
	Cheng-Xian	Lin		(305) 348-0537	lincx@fiu.edu	Florida International University
Mr.	Percy	Luney	Vice President	(321) 704-4404(321) 704-4404	pluney@spaceflorida.gov	Space Florida
	Miriam	Makhyoun	Research Manager	(828) 507-9089	Makhyoun.Miriam@gmail.com	Solar Electric Power Association
Mr.	Buck	Martinez	Sr. Directory, Office of Clean Energy	(561) 694-3254	katia.saint-preux@fpl.com	Florida Power & Light Company
Mr.	Marcel	Mattos	Student	+55 53-84048834	msmarcel@gmail.com	University of Florida
Dr.	Roger	McGinnis	Director, CAPS	(850) 644-1035	rainey@caps.fsu.edu	Florida State University
	Stephanie	Meyers		(630) 738-0533	sameyers93@yahoo.com	University of Illinois
	Sean	Meyn			meyn@ece.ufl.edu	
Mr.	Craig	Miller	Sr. Assoc. In	(352) 392-5684	craigmil@ufl.edu	UF/PREC
Mr.	Mike	Mitchell	Policy Analyst	(850) 617-7470	michael.mitchell@freshfromflorida.com	FDACS Office of Energy
Dr.	Nahid	Mohajeri	CEO	(772) 202-0675	nahid@hysensetechnology.com	HySense Technology LLC
	Francesca	Moloney		(518) 944-6705	flmoloney@mail.usf.edu	
	Wendy	Mussoline	Student	(352) 392-8699 (352) 392-8699	wmussoli@ufl.edu	University of Florida-Ifas
Dr.	Fazil	Najafi	Professor	(352) 392-9537 ext. 1493	fnaja@ce.ufl.edu	Engineering School of Sustainable Infrastructure and Environment
Mr.	Jin	Noh	Graduate Researcher	(703) 507-8809	nohj@berkeley.edu	UC Berkeley
Prof.	John	Nuszkowski	Assistant Professor	(904) 620-1683	john.nuszkowski@unf.edu	University of North Florida
	Kathleen	O'Neil	President	(407) 697-6794	koneil@pi-innovation.com	Partnering in Innovation, Inc.
Mr.	Nizamettin	Ogutman		(407) 590-2323	kortan.ogutman@gmail.com	
Mr.	Charles	Oladimeji		(816) 446-8226	cfo12c@my.fsu.edu	Florida State University
	Jim	Payne	Technical Project Officer	(720) 356-1744	jim.payne@ee.doe.gov	U.S. Dept. of Energy
	Marie	Peralta	Student	(352) 392-8699	mperalta@ufl.edu	University of Florida-Ifas
	Shane	Philhower	Student	(352) 392-8699	shanep@union.ufl.edu	University of Florida-Ifas
Dr.	George	Philippidis	Associate Professor	(813) 974-9333	gphilippidis@usf.edu	USF
Dr.	Michelle	Phillips	Junior Economist	(352) 392-6148	michelle.phillips@warrington.ufl.edu	University of Florida/ Public Utility Research Center
	Theresa	Purnell		(352) 338-3412	theresa.purnell@fl.usda.gov	
Dr.	Nan	Qin	Post Doctoral Research	(321) 638-1505	nqin@fsec.ucf.edu	Florida Solar Energy Center
Mr.	Scott	Ranck	Senior Conservation & Energy Specialist	863 224 ext. 2986	sranck@fpuc.com	Florida Public Utilities Company
Mr.	Kelvin	Randhir	Graduate Student		kelvinrandhir72@ufl.edu	University of Florida
Mr.	Robert	Reedy	Program Director		reedy@fsec.ucf.edu	Florida Solar Energy Center/ucf
	Ben	Rowland	Principal	(443) 253-0790	browland@universityproposals.com	University Proposals
	Claudia	Sanchez	Student	(352) 392-8699	cmsanchez@dental.ufl.edu	University of Florida-Ifas
Mr.	Thomas	Schmid	Graduate Student	(330) 429-4396	t.schmid@twenergy.net	Penn State University
Mr.	Eric	Schneller		(321) 638-1452	eschneller@fsec.ucf.edu	University of Central Florida / Florida Solar Energy Center
Ms.	Linda	Seals	Director/community Development Agent	(321) 633-1702 ext. 236	lseals@ufl.edu	Uf/ifas Extension Brevard County
Dr.	Hubert	Seigneur	Program Manager	(407) 970-2237	hseigneur@fsec.ucf.edu	Univ of Central Florida/PVMC
Mr.	Patrick	Sheehan	Managing Partner	(850) 524-6979	patrick@gregsongroup.com	Gregsongroup
Mr.	William	Sheftall	Extension Agent - Natural Resources	(229) 224-8470	sheftall@ufl.edu	University of Florida Ifas Extension
Dr.	Sesha	Srinivasan	Assistant Professor	(813) 451-1876	ssrinivasan@flpoly.org	Florida Polytechnic University
Prof.	Amy	Stein	Associate Professor	(352) 273-0953	stein@law.ufl.edu	U. of Florida Levin College of Law
Mrs.	Nina	Stokes	FESC Project Manager	(813) 259-6587	nstokes@hccfl.edu	Florida Advanced Technological Education Center (FLATE)
Mr.	Jeremy	Susac	Partner	(850) 561-3010	jsusac@bergersingerman.com	Berger Singerman LLP
Mr.	TJ	Szelistowski	Managing Director -Regulatory Affairs	813 228 ext. 1804	tjszelistowski@tecoenergy.com	Tampa Electric Company
Dr.	Arash	Takshi	Assistant Professor	(813) 421-3037	atakshi@usf.edu	University of South Florida (Usf)
	Nick	Taylor	Research Scientist	(352) 392-3121	nwtaylor@ufl.edu	University of Florida
Mr.	Rodrigo	Trevizan	Ph.D. Student	(352) 278-5440	rodtrevizan@ufl.edu	University of Florida
Dr.	Yicheng	Tu	Associate Professor	(813) 974-2114	ytu@cse.usf.edu	University of South Florida
Mr.	Robin	Vieira	Director, Buildings Research Division	(321) 638-1404	rob@fsec.ucf.edu	Florida Solar Energy Center
Dr.	Tim	Vinson	Research Coordinator	(352) 392-6264	tvinson@ufl.edu	Hinkley Center- UF
Ms.	Jeanne	Viviani	Contracts & Grants Manager	(863) 874-8534	jviviani@flpoly.org	Florida Polytechnic University
	Huali	Wang	Chief Chem Process Engineer	(772) 781-4300	hwang@vieselfuel.com	VIesel Fuel, LLC
Mr.	Venroy	Watson	Graduate Student	(770) 875-7414	venroy_watson@yahoo.com	Florida A&M
Dr.	Charles	Weatherford	Associate VP for Research	(850) 412-5091	charles.weatherford@famu.edu	Florida A&M University
Mr.	Michael	Welch		(813) 455-5840	mwelch3@mail.usf.edu	University of South Florida
Mr.	Stephen	Welty	President	(941) 227-0361	stephen.welty@calortechnologies.com	Calor Technologies Llc
Dr.	Ann	Wilkie	Professor	(352) 392-8699	acwilkie@ufl.edu	University of Florida-Ifas
Mr.	Herbert	Williams	CEO	(904) 868-1146	floridahydro@msn.com	Keuka Energy
	Na	Wu	Graduate Student	(352) 284-6422	wuna8703@ufl.edu	University of Florida

Prefix	First Name	Last Name	Title	Phone	Email	Company
	Shanna	Xia		(904) 654-4268	nana8581@ufl.edu	University of Florida
Mr.	Sam	Yang	Graduate Research Assistant	(937) 657-4156	syang@caps.fsu.edu	Florida State University
Mr.	Shunchang	Yang	PhD	(352) 281-8365	jack.shushu87@gmail.com	Agricultural and Biological Engineering
Ms.	Yingxiu	Zhang	Graduate Assistant	(352) 327-0292	yzhang88@ufl.edu	University of Florida
Prof.	Jim	Zheng	Professor	(850) 410-6464	zheng@eng.fsu.edu	FAMU-FSU College of Engineering
Mr.	Justin	Zhou	Chief Science Officer	(215) 469-0350	justin.zhou@ivcomposites.com	IV Composites
Prof.	Kirk	Ziegler	Associate Professor	(352) 392-3412	kziegler@che.ufl.edu	University of Florida
Mr.	Paul	Zombo	Engineering Manager	321 427 ext. 6760	paul.zombo@siemens.com	Siemens Energy
Prof.	Wangda	Zuo	Assistant Professor	(305) 284-5993	w.zuo@miami.edu	University of Miami

FESC

Florida Energy Systems Consortium