Organized by Florida Polytechnic University in collaberation with Florida Energy Systems Consortium

Renewable Energy Systems and Sustainability Conference

July 31- August 1, 2017

Table of Contents

Welcome Message	3
About RES&SC 2017	4
About FESC and Florida Polytechnic	5
Sponsors	6
Conference Organizing Committee	7
Agenda	8
Welcome Speakers	14
Plenary Talks	15
Keynote Talks	16
Breakout Session- Biomass/Biofuel	19
Breakout Session- Solar Energy/ Smart Grid/ Energy Storage	27
Breakout Session- Energy Efficiency/ Sustainability	32
Breakout Session- Education/ Workforce Development	37
Poster Session	43
Additional Information	69
Conference Participants Contact Information	77

WELCOME

Dear Conference Participants,

On behalf of Florida Energy Systems Consortium and the Organizing Committee, I welcome each of you to the 2017 "Renewable Energy Systems and Sustainability" Conference. This special event has been organized by Florida Polytechnic University (Lakeland, Fla., US) in collaboration and support from Florida Energy Systems Consortium (FESC). This conference hosting is part of Polytech's Educational and Curriculum Development grant funded by FESC.

This conference aims to foster knowledge, and provide networking opportunities towards collaborative research, education and workforce development. The conference will provide a forum to discuss global challenges in Renewable Energy and Sustainability fields with the aim of exchanging ideas and best practices during round table discussions. The conference will give attendees an opportunity to establish university-industry partnerships and shape futuristic degree programs on the conference topics. During the conference, you will meet distinguished professors, renowned scientists, engineers, industry leaders and students from the State of Florida, US and International. You will also have a chance to share your knowledge, participate in formal discussions, and explore opportunities to collaborate on new research and education solutions.

Before I close, I would like to thank you all for attending our conference and bringing your expertise. You, as leaders in energy field, have the vision, the knowledge, and the experience to help us pave our way into the future. You are truly our greatest asset today and tomorrow, and we could not accomplish what we do without your support and leadership. Throughout this conference, I ask you to stay engaged, keep us proactive and help us shape the Florida's energy future towards a better world.

Sincerely,

Dr. David P. Norton
VP Research and Director of FESC
University of Florida

ABOUT THE RES&SC 2017

This Renewable Energy Systems and Sustainability Conference aims to foster knowledge, research breakthroughs, education and workforce development and the conference hosting is part of our Educational and curriculum Development grant funded by Florida Energy Systems Consortium (FESC).

RES&SC 2017 brings academicians, industrialists, non-profits, government and other stakeholders on a platform to discuss and deliberate the challenges and issues implementing renewable energy and learn the best practices of such technologies. The conference kicks off with welcome address by Dr. David Norton, Director of Florida Energy Systems Consortium and Dr. Sesha Srinivasan, Assistant Professor of Physics at the Florida Polytechnic University, followed by an opening plenary talk by Mr. Garrett Nilsen of US DOE Sunshot Initiatives. Three keynote talks by subject experts from Tampa Electric (TECO Energy), FAU and The Mosaic Company will discuss the Renewable Energy Systems and Sustainability areas including marine energy.

Four different breakout sessions such as (i) biomass/biofuel, (ii) solar energy/smart grid/energy storage, (iii) energy efficiency and sustainability and (iv) education and workforce development will be conducted on both days of the conference, where invited speakers from academia and industry will deliver their lectures and interact with conference participants. A featured session related to formal round table discussion on the breakout topics will allow the focused group to brainstorm and come up with a moderator's report which will be presented to the entire audience on the second day of the conference.

Students' poster presentation and networking will occur on the first day of the conference in the evening before adjourn. The RES&SC 2017 final adjourn on the second day after listening to exciting closing plenary talk by Dr. Kelley Smith Burk of Office of Energy, State of Florida. Informal luncheon discussion on the first day and breakfast on the second day with coffee breaks will be served at the IST building of Florida Polytechnic University. Industry/Academia Exhibit booths will be set up in the IST building so please stop by these booths for more information.

RES&SC 2017 organizing committee welcome the participants, and thank the sponsors for the wonderful conference experience and networking.

-RES&SC 2017 Organizing Committee

ABOUT FESC

FLORIDA ENERGY SYSTEMS CONSORTIUM

FESC BRINGING ENERGY SOLUTIONS TO FLORIDA, THE NATION AND THE WORLD - The Florida Energy Systems Consortium (FESC) brings Florida statewide faculty together for energy research and also connects Florida industry with university research expertise and facilitates, resulting in improved technology transfer and commercialization. Since its inception in 2008, FESC has successfully promoted and forged collaborations among energy experts across Florida's universities, Florida industry, and other Florida state entities. These collaborations have led to a large, diverse, and comprehensive FESC network, resulting in alternative energy strategies, improved energy efficiencies, and expanded economic development opportunities within the state.

ABOUT FLORIDA POLYTECHNIC UNIVERSITY

Florida Polytechnic University (Florida Poly), started as a university of engineering and technology, is designed to be different so that graduates possess the talent and job-ready skills to stand out from the crowd. While other top engineering schools in Florida have centers of innovation, Florida Poly was established on April 20, 2012, as a wholly innovative university dedicated to the principle that innovation occurs when research and creativity are applied to real-world challenges. Florida's only public university for engineering and technology dedicated to science, technology, engineering and mathematics (STEM) was created to be both a rigorous academic institution and a powerful resource for high-tech industries. Florida Poly recently acclaimed initial regional accreditation from The Southern Association of Colleges and Schools Commission on Colleges (SACSCOC).

THANKS TO OUR PROUD SPONSORS

RES&SC 2017 organizing committee thank the following sponsors who have supported with financial assistance for the smooth functioning of this conference.

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AGENDA

MONDAY JULY 31, 2017

Time	Session	Room
09:00am-10:00am	**ON-SITE REGISTRATION**	**IST South Lobby**
10:00am-10:15am	**WELCOME & OPENING REMARKS** • David Norton, Director, FESC, VP for Research, University of Florida • Dr. Sesha Srinivasan, Assistant Professor of Physics	**Aula Magna 1001**
10:15am-11:00am	**OPENING PLENARY SESSION** **PLENARY-1:** Garrett Nilsen, Technology to Market Program Manager, US DOE SunShot Initiatives, "Looking to the Sky – Solar Power Today and Tomorrow"	**Aula Magna, 1001**
11:00am-11:10am	**GROUP PHOTO**	**IST South Entrance Staircase**
11:10am-11:30am	**COFFEE BREAK**	
11:30am-12:00pm	**KEYNOTE SESSION I** **KEYNOTE-1:** Thomas L. Hernandez, Senior VP for Strategy and Renewable Power, Tampa Electric/TECO Energy "Generating ReNEWable Possibilities"	**Aula Magna, 1001**
12:00pm-01:00pm	**LUNCH-INFORMAL ROUND TABLE DISCUSSION**	**Sadle Creek Logistics Commons**
01:00pm-02:00pm	**KEYNOTE SESSION II** **KENOTE-2:** Gabriel Alsenas, Director, FAU Southeast National Marine Renewable Energy Center, "Pioneering a Blue Energy Future" **KEYNOTE-3:** Subrata Bandyophadyay, Senior Manager, Environmental-Minerals, The Mosaic Company, "Sustain-ability at Mosaic"	**Aula Magna, 1001**
02:00pm-04:00pm	**BREAKOUT SESSION I**	

	BIOMASS/BIOFUEL **BIOMASS-1:** Laura Belicka, Senior Scientist, Algenol Biotech., "Algae-Based Biofuel Production in the Algenol Direct to Ethanol® Process" **BIOMASS-2:** John Kuhn, University of South Florida, "Processing of Gaseous Waste Streams to Renewable Fuels and Chemicals" **BIOMASS-3:** Ian Small, University of Florida, "Brassica Carinata: A Biofuel Feedstock Ready for Takeoff" **BIOMASS-4:** William Eggers, CEP, CWB, PWS, VP Science & Technology, AquaFiber Technologies Corporation, "An Effective and Sustainable Regional Surface Water Remediation and Biomass Production Process" **BIOMASS-5:** Wilfred Vermerris, University of Florida, "Integrated Bioprocessing of Sorghum for the Sustainable Production of Renewable Fuels and Chemicals" **BIOMASS-6:** Richard Blair, University of Central Florida, "Defect-laden 2D Materials for Enhanced Mechanocatalysis"	**Room 1002**
	SOLAR ENERGY/SMART GRID/ENERGY STORAGE **SOLAR-1:** Ngwe Zin, University of Central Florida, "Evaluation of Double-sided Pyramidal Texture for IBC Solar Cells" **SOLAR-2:** Paul Brooker, Florida Solar Energy Center, "Peak Shaving Applications Using EVs" **SOLAR-3:** Zhihua Qu, University of Central Florida, "Distributed Control and Optimization for High-Penetration Distribution Networks" **SOLAR-3:** Zhihua Qu, University of Central Florida, "Distributed Control and Optimization for High-Penetration Distribution Networks" **SOLAR-4:** Rick Meeker, Nhu Energy, "Advance Control Increases the Value of Distributed Energy Resources" **SOLAR-5:** Mike Aller, CAPE & Energy Florida, "Powering the Future from Florida – Combined Heat and Power Smart Grid and the CAPE"	**Room 1003**

	ENERGY EFFICIENCY/SUSTAINABILITY **EFFICIENCY-1:** Tim Franta, Energy Florida, "Unique Energy Technology Partnership at NASA Kennedy Space Center – The Test HUB" **EFFICIENCY-2:** Eric Martin, Florida Solar Energy Center, "Smart Mechanical Ventilation Approaches for Improved Comfort, Energy Efficiency and Indoor Air Quality in Homes" **EFFICIENCY-3:** Manny Garcia, Carrollwood Pools Inc, "The System Approach to Designing a Low Velocity Circulating System" **EFFICIENCY-4:** Nicoleta Sorloica-Hickman, Florida Polytechnic University, "Building a Net Zero Energy Campus and Culture at Florida Polytechnic University"	**Room 1067**
	EDUCATION/WORKFORCE DEVELOPMENT **EDUCATION-1:** Zhihua Qu, University of Central Florida, "FEEDER, A Distributed Technology Education/Research Center" **EDUCATION-2:** Juan Ordonez, Florida State University, "An Off Grid Zero Emission Building as a Connecting Block in Sustainable Energy Conversion Course" **EDUCATION-3:** Mohammad Rashid, Florida Polytechnic University, "Teaching a fully on-line Renewable Energy Course" **EDUCATION-4:** Niroumand Hamed, University of Florida, "A Systematic Review on Green Architecture and Educational Environments" **EDUCATION-5:** David Bruderly, Bruderly Engineering Associates, Jacksonville, FL, "So Climate Chaos is a Hoax?"	**Room 1068**
04:00pm-04:20pm	**COFFEE BREAK**	
04:20pm-05:00pm	**FORMAL ROUND TABLE DISCUSSIONS** ***MODERATOR + RECORDER FOR THE FORMAL ROUND TABLE DISCUSSION***	
	BIOMASS/BIOFUEL	**Room 1002**
	SOLAR ENERGY/SMART GRID/ENERGY STORAGE	**Room 1003**
	ENERGY EFFICIENCY AND SUSTAINABILITY	**Room 1067**
	EDUCATION AND WORKFORCE DEVELOPMENT	**Room 1068**

05:00pm-06:00pm	**STUDENT'S POSTER SESSION**	**IST South Entrance Lobby, 1st Floor**
06:00pm	**DINNER ON YOUR OWN**	

TUESDAY AUGUST 01, 2017

07:30am-08:30am	**CONTINENTAL BREAKFAST & NETWORKING**	**IST South Entrance Lobby, 1st Floor**
08:30am-09:10am	**ROUND TABLE REPORTS (10 MIN EACH)** Biomass/Biofuel; Solar Energy/Smart Grid/Energy Storage; Energy Efficiency and Sustainability; Education and Workforce Development (Moderator's report presentation)	**Aula Magna, 1001**
09:10am-09:30am	**COFFEE BREAK**	
09:30am-11:30am	**BREAKOUT SESSION II** **BIOMASS/BIOFUEL** **BIOMASS-7:** Fredy Altpeter, University of Florida, "Targeted Mutagenesis or Precision Nucleotide Substitution in the Complex Sugarcane Genome" **BIOMASS-8:** Brett Bailey, President and CEO IVHCO, "Bio Fueled Vehicles for Sustainable Global Clean Transportation" **BIOMASS-9:** Melba Horton, Florida Polytechnic University, "Power Up a Sustainable Future with Algae" **BIOMASS-10:** Steven Well, CEO, Pure Algae Growth Systems, "Pure Algae Growth Systems: A novel Technology for Large Scale Algae Feedstock Production" **BIOMASS-11:** Donald Rockwood, University of Florida, "Fast Growing Trees for Bioenergy"	**Room 1002**

	SOLAR ENERGY/SMART GRID/ENERGY STORAGE **SOLAR-6:** Yogi Goswami, University of South Florida, "New and Emerging Developments in Solar Energy" **SOLAR-7:** Rick Meeker, Nhu Energy Inc., "The Florida Alliance for Advancing Solar and Storage Technologies Readiness" **SOLAR-8:** Mohammad Rashid, Florida Polytechnic University, "Power Electronics Applications in Renewable Energy" **SOLAR-9:** Jaspreet Dhau, FL Polytechnic University, "Encapsulated Phase Change Materials for High Temperature Thermal Energy Storage"	**Room 1003**
	ENERGY EFFICIENCY/SUSTAINABILITY **EFFICIENCY-5:** Jason M. Mickel, Southwest Florida Water Management District, "Creative Partnerships for Sustainable Water Supply Solution" **EFFICIENCY-6:** Charles Withers Jr, Florida Solar Energy Center, "Evaluating Moisture Control of Variable Capacity Heat Pumps in Mechanically Ventilated, Energy Efficient Homes" **EFFICIENCY-7:** Juan Ordonez, Florida State University, "A Thermodynamic Perspective on Energy Efficiency" **EFFICIENCY-8:** Richard C. Feiock, Florida State University, "Politics, Messaging, and Energy Conservation Behavior of Municipal Utility Customers"	**Room 1067**
	EDUCATION/WORKFORCE DEVELOPMENT **EDUCATION-6:** Sesha Srinivasan, Ryan Integlia, Jaspreet Dhau, Florida Polytechnic University, "Renewable Energy Systems and Sustainability Education and Curriculum Development" **EDUCATION-7:** Ramona Madhosingh-Hector, University of Florida/IFAS Extension, "Building Sustainable Connections through Film Series"	**Room 1068**

	EDUCATION-8: Scott Wallen, Florida Polytechnic University, "Circular Economy Paradigm for Sustainable Redesign of Introductory Laboratories" **EDUCATION-9:** Jaspreet Dhau, Sesha Srinivasan, et al. Florida Polytechnic University, "International Course Curriculum and Development on Green Chemistry, Engineering and Technologies"	**Room 1068**
11:30am-12:00pm	**CLOSING PLENARY SESSION** **PLENARY-2:** Kelley Burk, Director, Office of Energy, Florida Department of Agriculture and Consumer Services	**Aula Magna, 1001**
12:00pm	**THANKS AND ADJOURN**	

WELCOME ADDRESS

Dr. David Norton, Vice President for Research and Director of FESC–David P. Norton, Ph.D., became vice president for research at the University of Florida in January 2012. He had served as associate dean for research in the UF College of Engineering since 2009. He is also a professor in the Department of Materials Science and Engineering.

Dr. Norton came to UF in 2000 after 11 years at Oak Ridge National Laboratory. His research interests primarily focus on electronic, photonic and magnetic thin film materials. He has published more than 300 articles in refereed journals and books, presented numerous invited papers and lectures at national and international conferences, and organized conferences and workshops in the areas of electronic oxides and laser processing. He is a Fellow of the American Vacuum Society, the American Physical Society and the American Association for the Advancement of Science, and a member of the Materials Research Society and the Electrochemical Society.

PLENARY SPEAKERS:

JULY 31 – 10:15-11:00 AULA MAGNA 1001

Looking to the Sky: Solar Power Today and Tomorrow

Garrett Nilsen, *US Department of Energy, Solar Energy Technologies Office*

Today, the $23 billion U.S. solar industry helps to power the economy, growing 68% every year since 2007. Worldwide, solar has created 3.1 million jobs, while supplying just 1% of total energy supply. There are still challenges ahead if solar energy is to power a significant percentage of the nation's—and world's—electricity, including grid integration, training, and business processes. U.S. Department of Energy SunShot Initiative is staying ahead of the fast-moving solar industry and helping to create a pipeline of innovation that will power the future industry. Join us for a discussion of what the industry faces in the decades to come.

Garrett Nilsen is the program manager for the Technology to Market team of US Department of Energy (Sunshot Initiatives), having spent the previous five years serving as a technology advisor for the team. He works with businesses of all sizes focusing on the development of innovative products and manufacturing technologies to help drive down costs and increase the deployment of solar energy.

prior to joining SunShot, Garrett was in graduate school in Sweden and Germany. Prior to that, he worked for Technologies Solutions and Invention, a small business in Connecticut that was an awardee on government contracts to develop optics-based devices for various government customers. Garrett has a B.S. in physics from Union College (NY) and an M.S. in solar energy engineering from Dalarna University in Sweden.

AUGUST 1 – 11:30-12:00 AULA MAGNA 1001

Kelley Smith Burk serves as the Director for the Florida Department of Agriculture and Consumer Services' Office of Energy. The office is responsible for the development of energy policy and programs for the state as well as promoting the use of renewable energy and energy efficient technologies. Mrs. Burk's responsibilities include supervision and oversight of policy development, program and grant design, and legislative tracking.

Prior to her work with the Office of Energy, Mrs. Burk worked with the Florida Department of Environmental Protection's Office of Strategic Projects and Planning. In this role, Mrs. Burk staffed the Governor's Action Team on Energy and Climate Change, providing a range of services including managing the transportation and land use technical working group, developing reports and helping draft the Team's Phase I and Phase II reports. Mrs. Burk holds a Bachelor of Arts degree in History from Florida State University and a Master's degree in Public Policy from Pepperdine University.

KEYNOTE TALKS

JULY 31 – 11:30-12:00 AULA MAGNA 1001

Keynote-1: Generating ReNEWable Possibilities

Thomas Hernandez, Business Strategy and Renewables, Tampa Electric

Discuss Tampa Electric's perspective on the business and operational challenges related to the development and deployment of renewable utility scale solar PV systems and community solar systems. Additional challenges include seeking appropriate regulatory treatment, customer acceptance and developing new energy forecasting and resource planning modules and methods. Tampa Electric is also currently evaluating other supporting technologies and systems to facilitate grid modernization including: energy storage, electric vehicles, AMI and LED street lighting.

Thomas L. "Tom" Hernandez is senior vice president of Business Strategy and Renewables for Tampa Electric. He has primary responsibility for developing and securing approval of the strategic growth plan for Florida operations and developing clean and sustainable renewable energy technologies that will be transformative and affordable for the company's nearly 730,000 customers.

Previously, Hernandez was vice president of Energy Supply, vice president of Energy Delivery and Customer Services and vice president of Regulatory Affairs. He joined Tampa Electric in August 1982 as an associate engineer in the Production Department. During his career with the company, he has held a variety of positions in operations, engineering, planning, marketing, fuels and environmental.

Hernandez received his Bachelor of Science degree in chemical engineering from Louisiana State University. He is a member of the American Institute of Chemical Engineers.

Hernandez serves on the board of The Florida Aquarium. He previously served eight years on the Children's Board of Hillsborough County, including as chair and treasurer. He is a past executive board member and chair of the Resource Working Group of the Florida Electric Power Coordination Group.

JULY 31 – 01:00-01:30 AULA MAGNA 1001

Keynote-2: Pioneering a Blue Energy Future

Gabriel Alsenas,

Southeast National Marine Renewable Energy Center, Florida Atlantic University

When we think of renewables, we often imagine "green" options like wind, solar, biomass. However, not all regions enjoy access to the resources needed to leverage these new technologies, or natural resources aren't adequate to significantly offset traditional energy generation. However, coastal areas have access to both kinetic and potential energy-rich options like waves, tides, ocean currents, and ocean gradients. We like to think of these renewable sources as "blue energy" options that are compatible not only with other locally available mature renewables, but also with

existing generation. Arguably, Florida is best positioned to lead the world in ocean current energy, which boasts very unique characteristics among all renewables – high capacity factor, predictability, and dispatch-ability. This talk will explore Florida's opportunities, challenges, and progress to becoming a global leader and pioneer in blue energy development.

Gabriel Alsenas serves as a General Manager at Florida Atlantic University's (FAU) Southeast National Marine Renewable Energy Center (SNMREC). Established as one of three U.S. Marine renewable energy centers in 2010. SNMERC seeks to advance the recovery of utility-scale energy from the Ocean's renewable resources with special emphasis on those resources available to the Southeastern US: ocean currents and thermal gradients. The Center works with industry, academia, and government to provide test infrastructure, in situ measurements, and other key enablers.

Prior to joining the Center in 2007, Mr. Alsenas worked as a graduate student engineer for the Department of Ocean Engineering at FAU, focused on US Navy future projects, prototypes, and sensor systems. Mr. Alsenas completed his B.S. and M.S. degrees in Ocean and Systems Engineering at FAU after a five year sabbatical from The Ohio State University to found an international internet consulting business.

Mr. Alsenas is an advanced AAUS scientific diver and voting member of FAU's Diving and Boating Safety Committee. He is the Convener of IEC/ISO's TC-114 Ad Hoc Group 4 (tidal power performance) technical standards development project team, Chief US delegate for the IECRE certification and conformity Marine Energy Operating Management Committee, Treasurer of the US National Committee for IEC's Renewable Energy Conformity Assessment, and a judge at FIRST Robotics FRC Competitions

JULY 31 – 01:30-02:00 AULA MAGNA 1001

Keynote-3: Sustainability at Mosaic

Subrata Bandyophadyay Environmental-Minerals, The Mosaic Company

When it comes to sustainability Mosaic is responsible, innovative, collaborative and driven. We think about sustainability broadly, in the true meaning of the word—the ability to sustain our business: Our social license to operate; our costs; our financial, safety and environmental performance; and our commitment to our communities…. all contribute to our sustainability and our ability to generate returns for shareholders. We set measurable goals and hold ourselves accountable for the reduction of waste, water use and greenhouse gas (GHG) emissions while increasing electrical cogeneration and our use of alternative energy sources. In 2015, Mosaic announced three measurable 2020 Environmental Targets to track our performance in freshwater and energy use, and GHG emissions.

As a demonstration of our commitment to Nutrient Stewardship and fertilizer best management practices, Mosaic advocates 4R philosophy of applying the Right fertilizer source at the Right rate, at the Right time, and in the Right place. Mosaic has been widely recognized for our corporate responsibility. For the seventh consecutive year, Mosaic was ranked by Corporate Responsibility Magazine as one of the nation's 100 Best Corporate Citizens, and we once

again achieved ranking on CDP's 'A' List for our efforts to reduce our energy use and greenhouse gas emissions. This presentation will highlight the key accomplishments and the initiatives that are ongoing within Mosaic as a part of our commitment to sustainability.

Dr. Subrata Bandyophadyay (Bandy) currently serves as a Senior Manager in the EHS group at Mosaic, and is responsible for regulatory compliance and monitoring of the Phosphate Operations, which include several mines and fertilizer manufacturing facilities in central Florida. Previously Dr. Bandy held corporate positions at Mosaic as Water Strategy Manager, and was involved in developing long term strategies for water resources in the US. He has a Doctor of Science in Environmental Engineering from Tulane University in New Orleans, an MBA from University of South Florida, Tampa, and a Bachelor of Civil Engineering degree from India. Dr. Bandy is a registered professional engineer in Florida and Louisiana. He has been a Tampa resident since 1998.

Previously Dr. Bandy served as a senior leader in the engineering consulting industry. His consulting experience includes management of diverse projects in the areas of watershed management plans, water quality studies, natural system restoration, and environmental impact analysis. His publications include articles in peer reviewed journals and book chapters, and conference presentations in national and international conferences.

BREAKOUT SESSIONS - INVITED TALKS

BIOMASS/BIOFUEL ROOM 1002

JULY 31 – 02:00-04:00 AUGUST 01 – 09:30-11:30

Biomass -1: Algae-Based Biofuel Production in the Algenol Direct to Ethanol® Process

Laura Belicka

Algenol Biotech, Fort Myers, Florida

Biofuels have great potential as low-carbon alternatives to fossil-based transportation fuels, and can serve as drop-in fuels for existing transportation infrastructures. Algenol's Direct to Ethanol® process relies on cyanobacteria (blue-green algae) for producing ethanol with residual biomass funneled to a biocrude co-product[1]. Here, we present an overview of Algenol's technology, highlighting the genetic engineering that enables ethanol production in the cyanobacteria and the diversion of over 75% of the fixed carbon into the ethanol pathway with a low carbon footprint[2,3] and provide examples of ethanol and biomass production in outdoor cultures contained in large photobioreactor arrays. Particular emphasis will be placed on biological innovations and photobioreactor design evolution and the implications of these changes on productivity and technology commercialization.

[1]For more information see www.algenol.com. This talk summarizes the work of over 120 Algenol employees in Fort Myers, Florida and Berlin, Germany.

[2]D. Luo, Z. Hu, D. Choi, V.M. Thomas, M.J. Realff, and R.R. Chance, "Lifecycle Energy and Greenhouse Gas Emissions from Ethanol Produced by Algae", Environmental Science and Technology 44, 8670 (2010).

[3]R. P. Lively, P. Sharma, D. Luo, B. McCool, J. Beaudry-Losique, V. Thomas, M. Realff, and R. R. Chance, "Anthropogenic CO_2 as a feedstock for the production of algal-based biofuels", Biofuels, Bioproducts, and Biorefining 9, 72-81 (2015).

Biomass -2: Processing of Gaseous Waste Streams to Renewable Fuels and Chemicals

John N. Kuhn

Department of Chemical & Biomedical Engineering, University of South Florida, Tampa 33620

Gaseous streams are often emitted directly or indirectly (flared), which results in carbon emissions and under-utilized energy sources. The challenges are that the emissions often have low energy content, are small in scale, and are remotely located. Our group at USF focuses on developing processes with integrated catalytic operations to convert these waste streams to usable fuels and chemicals. Two case studies using novel processing approaches will be used as illustrations. First, the conversion of biogas and landfill gas to diesel fuel using catalytic tri-reforming and CO hydrogenation in series will be discussed. In the second example, periodic cycling will be used to convert concentrated carbon dioxide to syngas, which can be subsequently used for fuel and/or chemical production via renewable hydrogen. In addition to the catalytic and material aspects, both economic and environmental implications of the research and processes will be discussed. The long-term implications of this research are envisioned to provide platforms for transportation fuels and chemicals with minimal carbon emissions.

Biomass -3: Bassica carinata: a biofuel feedstock ready for takeoff

Ian M. Small, Sheeja George, Ramdeo Seepaul, and David Wright

North Florida Research and Education Center, University of Florida, Gainesville, FL

Brassica carinata (carinata), an oilseed crop, can be used as a non-edible industrial oil feedstock with highly desirable fuel chemistry for 'drop in' aviation fuels. Interest in carinata as a biofuel feedstock is motivated by a strong foundation of research into carinata agronomics and management, a good fit into existing agricultural infrastructure, a proven conversion process for fuel development with consequent interest from military and commercial aviation sectors, and demonstrated market demand for numerous fuel coproducts and bioproducts from carinata seed meal. These factors have positioned carinata on the verge of broad commercialization in the southeastern United States. Underutilized "off season" row crop land will be used in the winter season to produce an economically competitive fuel crop that provides ecosystem services while economically enticing growers to make full use of their resources. This has led to the critical need to understand performance of carinata within existing cropping systems and to devise strategies to maximize productivity of the bioenergy crop and the producer's primary summer crop. Successful public-private partnerships among the University of Florida, Agrisoma, and Applied Research Associates has laid a strong foundation for a carinata-based biofuel and bioproduct supply chain in the southeastern United States

Biomass -4: AquaLutions®™ - An Effective and Sustainable Regional Surface Water Remediation and Biomass Production Process

William Eggers

Aqua Fiber Technologies Corporation, Winter Park, FL 32793-4815

AquaFiber Technologies Corporation's water remediation technology called AquaLutions®™ cleans natural surface waters by harvesting the algae, cyanobacteria and other suspended solids from them. By flowing millions of gallons of water per day, this process produces clear, oxygenated water while removing tons of phosphorus and nitrogen, and millions of pounds of organic material made primarily from algae and cyanobacteria each year. This biomass has been used as a feedstock for various forms of energy or fuel production. It has advantages over other feedstocks when converted to electricity using gasification, anaerobic digestion or a fluidized gas bed. It has also been converted to JP-8 jet fuel, high altitude dry fuel and pure hydrogen gas. Non-energy producing uses proven include fertilizer in raw or pelletized form, building products and plastic alternatives. The act of harvesting the biomass is also an effective carbon capture and wetland mitigation method. Depending on a combination of factors including scale, location, water quality and the end goals, AquaLutions®™ and beneficial biomass conversion can be linked to create an effective and sustainable way to provide regional surface water remediation and renewable product development.

Biomass -5: Integrated Bioprocessing of Sorghum for the Sustainable Production of Renewable Fuels and Chemicals

Wilfred Vermerris

Department of Microbiology and Cell Science, University of Florida, Gainesville, FL

Due to its low input requirements compared to sugarcane and maize, its tolerance to a wide range of growing conditions, and potential for high biomass yield, sorghum is an attractive source of fermentable sugars for the

production of renewable fuels and chemicals. Fermentable sugars can either be obtained directly by extracting the juice from sweet sorghum stems, or by hydrolyzing the cellulose in sorghum biomass. Microbial biocatalysts can use these sugars to produce fuels (e.g. ethanol, butanol) or platform chemicals (e.g. lactic acid, succinic acid) for bio-based polymers. Environmental and economic sustainability are key factors for the long-term success of this biorefinery process. Sorghum breeding efforts at the university of Florida have focused on regional adaptation of this crop, specifically by 1) ensuring high yields of soluble sugars and biomass as a result of resistance to prevalent fungal diseases, 2) improved water use efficiency to minimize the need for irrigation, and 3) enhanced biomass composition that enables more efficient release of sugars from biomass. The efficiency of biomass conversion is enhanced through the use of a phosphoric acid pretreatment followed by liquefaction and simultaneous co-fermentation of pentose and hexose sugars by microbial catalysts with enhanced tolerance to inhibitors (furfural, HMF). The solid residues remaining from this process are being used for the production of polymers with enhanced thermo-elastic properties as well as nanomaterials with biomedical applications, while the ammonium- and phosphate-rich liquid residue can be used as fertilizer. Economic and life cycle analyses projected that a 20 million gallon-per-year sweet sorghum bagasse-to-ethanol facility would support 732 jobs in rural areas, raise the state GDP by $55.4M and state and local tax revenues by $6.3M, with the added benefit of reducing the emission of greenhouse gasses by 60% relative to the use of gasoline.

Biomass-6: Defect-laden 2D Materials for Enhanced Mechanocatalysis

Richard Blair

Department of Physics, University of Central Florida, Orlando, FL 32816

Mechanocatalysis or facilitation of catalysis through the application of mechanical force in a ball mill offers the potential for realizing increased catalytic rates and novel reaction pathways with lower energy use. The implementation of catalysis in a mechanochemical reactor requires an understanding of the mechanical behavior of a catalyst as well as the desired surface reactions. Very high transient pressures (upwards of 6000 bar) and high shear facilitate catalysis through defect formation and limited heating. Defects can be introduced into *h*-BN, MoS_2, and δ-MoN forming *dh*-BN, *d*-MoS_2, and *d*δ-MoN through grinding. We found good olefin hydrogenation rates over dh-BN, production of methanol from syngas over unpromoted *d*-MoS_2 and the potential for ammonia synthesis over *d*δ-MoN. Challenges to scale-up are mitigated in a mechanocatalytic reactor since reactions only occur at each impact. Efficient processing of hydocarbons through mechanocatalysis allows energy intensive products and fuel compounds to be produced efficiently and economically.

Biomass -7: Targeted Mutagenesis or Precision Nucleotide Substitution in the Complex Sugarcane Genome

Fredy Altpeter, Baskaran Kannan, Tufan Mehmet Oz, Je Hyeong Jung, Ratna Karan, Aldo Merotto.

Agronomy Department, Plant Molecular and Cellular Biology Program, University of Florida - IFAS, Gainesville, FL.

Programmable endonucleases like RNA-guided nucleases (e.g.CRISPR/Cas9) or transcription activator-like effector nucleases (TALENs) enable precise genome modifications. Targeted mutagenesis for "loss of function" is typically more efficient than gene replacement for "gain of function" since it does not require template mediated homology directed repair (HDR) and instead relies on the more efficient but error prone non-homologous end joining (NHEJ)

DNA-repair pathway. However, sugarcane is a highly polyploid species (x=10-13) which may require knock-out of a very large number of alleles/copies for "loss of function" mutants. Suppression of lignin biosynthesis can improve bioethanol production from lignocellulosic biomass. Recently we described TALEN induced mutagenesis to suppress one of the lignin biosynthetic genes, caffeic acid O-methyltransferase (CO*MT*), resulting in low lignin and brown-midrib sugarcane phenotypes. Here we will describe Sanger sequencing of long CO*MT*amplicons from brown-midrib sugarcane, which allowed us to precisely determine the number of copies/alleles which were co-mutated. Data describing the cell wall composition of CO*MT* mutants and their agronomic and conversion performance will be presented. A gene-editing approach conferring a selectable, "gain of function" phenotype by creating herbicide resistance will also be discussed. This involves a DNA repair template facilitating homology-directed repair (HDR) and CRISPR/Cas9 as programmable endonuclease.

Biomass -8: Bio Fueled Vehicles for Sustainable Global Clean Transportation

Brett Bailey

IVHCO, Fort Myers, FL

Today's gasoline and diesel fueled vehicles are indirectly solar powered vehicles. The fuels used to power these vehicles are the result of sunlight that reached our planet and helped plants and animals to thrive long ago. This rare combination of natural events, that feed the current energy driven economy, is not sustainable. The sustainability is challenged because there are relatively finite oil reserves and because the combustion of these fuels release the Green House Gas (GHG) Carbon Dioxide (CO_2).

Current Biofuel technology and fuel providers accelerate the process of converting sunlight into a useable energy dense liquid energy medium. The production of biofuel requires Carbon Dioxide as an input, so the production of biofuel is more carbon neutral than oil based fuel making it more environmentally sustainable. Of these new fuels, Biodiesel is one of the best biofuels on the market today, but traditional biodiesel is not a drop-in replacement for diesel fuel. Current diesel engines are not capable of operating with Biodiesel levels above 20%.

Global Clean Diesel (GCD) Corporation has been researching and developing Cool Particulate Regeneration (CPR) as a low-cost emissions reduction technology that will enable higher percentages of Biodiesel to fuel future diesel engines. Florida Polytechnic University is assisting GCD research and development of its technology to reintroduce engine generated Particulate Matter (PM) into fuel. Current emissions control equipment in state of the art diesel vehicles utilizes significant amounts of diesel to incinerate PM and generates GHG production. The combination of Biodiesel and GCD technology will reduce GHG production.

Our presentation will highlight Global Clean Diesel and Florida Polytechnic University's ongoing development of Biodiesel in conjunction with GCD technology.

Biomass -9: Power up a Sustainable Future with Algae

Melba Horton

Florida Polytechnic University, 4700 Research Way, Lakeland, Florida 33805

Algae are the ultimate primary producers in the aquatic environments. Their tremendous diversity contributes a large proportion to the world's total biomass. A huge fraction of which naturally supports the consumers in the

food chain to sustain the life of the entire planet. This attribute is made possible because of their ability to survive in various habitats through their unique physical characteristics and the production of substances with remarkable chemical properties. Some of the algal species that have been personally studied include Sargassum crassifolium, an algal species that produces alginate, a compound used in pharmaceuticals, cosmetics, textiles, and even dental impressions. Using laboratory and field techniques that we have developed, coastal population that was denuded due to sand quarrying activities was restored. Farming of the sea grape, Caulerpa lentillifera was explored due to its high antioxidant properties which served as a food commodity in many Asian countries. Undaria pinnatifida is a highly farmed seaweed species in Japan for food and for its alginate and fucoidan contents. It was determined that the blades and sporophylls produced the highest alginate while the stipe contained the lowest. Diatoms, on the other hand, are explored for their lipid production as source of biofuel. Results showed that different species produce varying amounts of lipid. Moreover, diatom frustules are made of biogenic silica with perforations in nano-scale dimensions that are currently explored for various industrial applications including energy storage for supercapacitor production. Results showed that the dielectric constant of diatom frustules is higher than amorphous silica. Another application currently explored is the use of frustules to enhance the porosity of phosphatic clay which shows very promising results. Generally, for a sustainable future, the potential of algae for biofuel and energy applications should be explored in conjunction with biomass production

Biomass -10: Pure Algae Growth Systems: A novel technology for large scale algae feedstock production

Martin L. Johnson, Steven E. Weil

Pure Algae Growth Systems, 764 Chesapeake Drive, Tarpon Springs, FL 34689

Introduction:

The majority (90% +) of commercial algae growing systems are open to the environment and mimic nature's pond growth (open raceway ponds). These promote a struggle for "survival of the fittest". Frequently wild algal strains or predators are introduced which destroy the pure strain culture desired by most commercial installations. Water and land use demands for large scale biomass feedstock production in open raceways are economically unrealistic. A number of smaller closed systems include indoor batch systems using fermentation. Current closed-loop photo-bioreactor systems are severely limited in flexibility and the capability to modify the temperatures and pressures in the actual growing media. Such limitations hinder scale up to the extent that commercially viable production rates have stalled for lack of innovation. The Pure Algae Growth System (PAGS) process eliminates the critical shortcomings of current commercial algae growing technology.

Technology Description:

The proposed process technology will improve the way algae is grown. It accomplishes this by totally protecting the growing media, cleaning all incoming materials that contact the media, and providing optimal growing conditions for the specific algae strain grown. The system comprises a pressurized mixing and recycling chamber, pressurized modular transparent flexible light reactors (100mm I.D. x 100 meters Length), and a liquid pumping system capable

of circulating the algal culture in turbulent flow greater than a Reynold's number of 10,000. The pressurized mixing chamber ensures that inputs (macro- and micronutrients, fresh medium, and makeup water) are efficiently and homogeneously distributed throughout the entire system. Additionally, the chamber allows efficient introduction of CO_2 and removal of excess oxygen. It provides pressure needed to drive the algal culture into the modular light reactors and through the entire loop for return to the mixing tank. It recycles all unused materials resulting in significant efficiency improvements in almost all categories. The result is a dependable, robust system/facility providing a predictable algae biomass output at a known cost.

The Pure Algae Growth System technology is designed to ensure high feedstock growth rates, predictable growth cycles, and almost total immunity from outside contamination. The system is engineered for the purpose of growing selective monoculture algae in a safe, convenient and economic manner. Unlike open raceway ponds, this novel system offers a closed environment where outside influences are virtually nonexistent. Materials such as nutrients, diluents, and carrier media are carefully screened and cleaned to an almost sterile condition. Factors such as nutrient concentration, temperature and chemical levels are all optimized for the growth of a specific algal species.

Due to the tightly controlled design, the system is well-suited to the large scale growth of single algae feedstock for high value applications and food grade material. The reverse benefit is scaled-up growth of GMO algae grown for a specific end-product. Modified algae strains are securely contained within the closed PAGS process without risk to native species. Modifications can be made to ensure that the end use of the microalgae feedstock is taken into account. All requirements of the cultured species are met including specific growing conditions such as nutrients and light. Other modifications involving the type of dewatering required, uses of

non-potable water, waste waters, addition of fixed carbon substrates or use of industrial carbon dioxide emission can be added without operational risk.

The PAGS sanitary process eliminates species "crash" due to algae species predators as is common in ORPs. With PAGS, predators can't get in. Only pure monoculture algae is grown; the resulting biomass is ready for downstream processing. ORPs cannot approach the security or sanitation offered by PAGS. Eliminating the risk of algae media contamination from foreign entities reduces production cost while increasing algae biomass yield. The techniques and equipment employed are widely known in pharmaceutical and microelectronic manufacturing.

Pure Algae Growth Systems (PAGS) bypasses the shortcomings of open raceway ponds (ORPs). The system is based on typical chemical engineering procedures associated with successful plant design and operations. Algae growth rates are higher in continuous systems utilizing central functions to control and support additional production operations. Batch systems (all ORP algae growth systems) cannot realize these benefits. However, ORPs are the dominant technology in commercial algae production. Compared to ORPs, PAGS reduces land use via its compact design, 24/7/365 grow / harvest capability and innovative flexible PBR tubing in 100 meter "runs". Our 8 acre facility is designed to out-produce ORP farms sitting on over 5000 acres.

PAGS significantly reduces the amount of water used in processing and harvest. Over 95% of the water is recycled and reused. ORPs evaporate a large portion of their water each day causing frequent, expensive replenishment. PAGS design provides efficient utilization of nutrient inputs. Carbon dioxide and other nutrients are introduced to the liquid media under pressure thereby making them continually available to the algae. The system is designed for change-over in only minutes from photosynthesis to heterotrophic growth modes. PAGS grows algae at night, ORPs

cannot. With its many inherent system engineering, cost, land and resource use benefits versus ORPs, PAGS is poised to become the dominant algae biomass feedstock production platform.

Summary:

The PAGS process technology has the potential to radically disrupt the way algae is grown and used. The biomass feedstock industry continues its long-running struggle to achieve large-scale algae growth without utilizing an economically excessive quantity of land, water and nutrient inputs. The proposed process system is designed for species control, optimal growth rates and maximum economies of scale. Potential impacts in the near-term include using PAGS for the production of high value items such as foods, nutraceuticals or APIs. Producers of end-products will benefit from stable supply and the lowering of feedstock prices. As the feedstock market evolves and supply increases, the lower cost of algae feedstocks will make commodity products such as biofuels an attractive possibility.

Plant Size	Biomass Output	System Capacity	Tank (Liters)	Circulation PBR (Liters)	Photo-bioreactor PBR (Meters)
DEMO	1 MT / YR	11K Liters	7K	4K	500
1SGM	4 MT / YR	23K L	15K	8K	1,000
10SGM	40 MT / YR	230K L	150K	80K	10,000
100SGM	400 MT / YR	2300K L	1.5M	800K	100,000

Plant Size	Biomass Output	CAPEX	OPEX	Site Size	Site Size
DEMO	1 MT / YR	$2,250,000	$340,000	1200 M^2	50'x250'
1SGM	4 MT / YR	$5,000,000	$1,300,000	12K M^2	3 acres
10SGM	40 MT / YR	$10,000,000	$2,700,000	32K M^2	8 acres
100SGM	400 MT / YR	$20,000,000	$5,400,000		

Plant Size	Biomass Output	Cost AFDW $ / KG	Cost $ / LB	Cost $ / Ton
DEMO	1 MT / YR	$340	$154.55	$309,091
1SGM	4 MT / YR	$325	$147.73	$295,455
10SGM	40 MT / YR	$68	$30.68	$61,364
100SGM	400 MT / YR	$43	$19.55	$39,091

*This abstract will also be presented in Poster Session

Biomass -11: Fast Growing Trees for Bioenergy

Donald Rockwood, Randall Bowman

School of Forest Resources and Conservation, University of Florida, Gainesville, FL

Fast growing trees such as eucalypts have a number of potential bioenergy applications. We describe their general importance with specific emphasis on existing and emerging markets as energy products and the potential to maximize their productivity as short rotation woody crops. Many conversion technologies are well understood, and several are being developed. Biomass characteristics, difficulty in securing adequate and cost effective supplies early in project development, and planning constraints currently prevent Eucalyptus bioenergy from reaching its full potential. For Florida and similar locations, we document their current energy applications and assess their productivity as short-term and likely long-term energy and related products. Increased biomass productivity and quality, prospects for carbon trading, distributed energy systems and hydrogen, multiple products from biorefining, and government incentives should foster the use of fast growing trees for bioenergy.

BREAKOUT SESSIONS - INVITED TALKS

SOLAR ENERGY, SMART GRID & ENERGY STORAGE

ROOM 1003

JULY 31 – 02:00-04:00 AUGUST 01 – 09:30-11:30

Solar -1: Evaluation of double-sided pyramidal texture for IBC solar cells

Ngwe Zin

CREOL, Florida Solar Energy Center, University of Central Florida, Orlando, FL

Interdigitated back-contact (IBC) solar cells developed in the past three years have efficiencies in the range 24.4%–25.6%. As high as these efficiencies are, there are opportunities to increase them further by improving on the light trapping. Ray tracing by Campbell and Green indicated that cells with texture on their front and rear surfaces are capable of superior light trapping than cells with texture on just their front. Of the geometries they tested, the best light trapping was attained by perpendicular grooves. Such a structure requires masked patterning for both front and rear surfaces, introduce significant complications to its incorporation into cells. To date, the results experimental cells with perpendicular grooves have not been published.

A second simpler option for double-sided texture is pyramids on the front and rear surfaces. Theoretically, the light trapping they provide is not quite as good as perpendicular grooves but they can be formed without patterning. One of the principle losses of double-sided pyramidal texture is the light that escapes after a second pass through the cell when the facet angles are the same on the front and rear. Here we investigate how this loss might be reduced by changing the facet angle of the rear pyramids. We also evaluate the reduction in surface recombination that rounding the facets introduces.

In this work, ray tracing was applied and the results of Campbell and Green were replicated. Next, smoothening the pyramids with HF: HNO_3 (1:10) was investigated by varying the time of the rounding etch over the range 0–90 s. With spectrophotometry and photoluminescent spectroscopy, the rounding etch time required to yield the best light trapping in each case was identified. Photoconductance lifetime measurements show that the surface recombination continues to decrease as the rounding time increases. These results indicate the presence of an optimal rounding etch time, with cell simulations suggesting an increase the cell efficiency by 0.3% absolute relative to a planar rear surface.

Solar -2: Peak Shaving Applications Using EVs

Paul Brooker

Florida Solar Energy Center, 1679 Clearlake Rd, Cocoa, FL 32922, USA

Electric vehicles (EVs) have been promoted as potential energy sources for a variety of applications beyond

transportation: vehicle-to-home (V2H), vehicle-to-building (V2B), and vehicle-to-grid (V2G), collectively known as "V2X". The potential revenue for V2X applications strongly depends on the electricity rate structure as well as the ability of the battery to meet the required demands. Additionally, the impact of V2X on battery lifetime due to the additional charge/discharge cycles is unclear, largely due to the uncertain demand profiles that will be imposed. This presentation will explore a strategy for using electric vehicles in a peak shaving application in order to determine the potential for reducing building peak demand, while minimizing charge/discharge cycles on the battery. A case study will be presented which models the increased cycles required of an EV battery to support V2B activities. The influence of PV and energy management systems on V2B responses will also be presented.

Solar -3: Distributed Control and Optimization for High-Penetration Distribution Networks

Zhihua Qu

Department of ECE, University of Central Florida, Orlando, FL 32816

In order to operate power systems reliably and securely with extremely high penetration of distributed energy resources (DERs), it is imperative to develop, demonstrate and implement modular and scalable technologies that enable advanced distribution operation and control functions in distribution networks. In this talk, distributed algorithms are presented for DER clustering, self-organizing neg-generation control, topology estimation, state estimation, optimal power flow with stochastic uncertainty, frequency control, volt-VAR optimization toward a uniform voltage profile, and system restoration. By employing these algorithms in real-time operation and control, integration of DERs and demand response functions becomes plug-and-play in a large scale distribution network. Dynamic analysis as well as integration of distributed control and wide area control will also be outlined.

Solar -4: Advanced Control Increases the Value of Distributed Energy Resources

Rick Meeker[1], MD Omar Faruque[2], Emmanuel Collins[3], Juan Ospina[2], Alvi Newaz[2],

Griffin Francis[3], Nikhil Gupta[3], Mario Harper[3]

[1] Nhu Energy, Inc.; [2] Florida State University, Center for Advanced Power Systems; [3] Florida State University, Center for Intelligent Systems, Control, and Robotics

Grid connected renewable generation, particularly solar PV and wind, has experienced consecutive years of substantial and steady growth in the U.S. and other parts of the world. To help address the intermittency, energy storage is beginning to grow, and, California is promoting this growth with policy. These and other resources are increasingly connected and coordinated at local points of connection in the form of microgrids. The potential value of distributed energy resources (DER), including renewable and traditional generation, energy storage, electric vehicles, and responsive load are increasingly recognized. As penetration levels of grid-connected DER increase, there is a substantial additional value that can be realized by maximizing the effective use of DER as a group, considering the different characteristics of each, incorporating forecasting where appropriate, and contemplating changes in energy market and rate design that enable and incentivize improved coordination and control. While decades of research, development, and engineering have focused on improving and reducing the cost of individual DER technologies,

there is now an ever increasing focus on developing the intelligence required to optimally deploy and utilize DER in combination. This talk will discuss the role of intelligent controls, and particularly optimal control approaches, in addressing this opportunity and recent efforts, including a collaborative Dept. of Energy funded project underway at Nhu Energy, Inc. and Florida State University to develop new effective solutions for optimizing the use of solar PV in combination with energy storage other DER.

Solar -5: Powering the Future from Florida – Combined Heat and Power, Smart Grid and the CAPE (Consortium for Advanced Production and Engineering of Gas Turbines and Rotating Machinery)

Mike Aller

Executive Director, Consortium for Advanced Production and Engineering of Gas Turbines and Rotating Machinery (CAPE) & Energy Florida

The NIST Advanced Manufacturing Technology Consortium (AMTech) for Advanced Turbine Manufacturing Technologies - the Consortium for Advanced Production and Engineering of Gas Turbines and Rotating Machinery (CAPE) based in Florida has resulted in robust cross-industry collaboration to advance technology development across the U.S. gas turbine sector. Gas turbines are increasingly being applied to provide "tune-able" baseload and dispatchable power solutions that improve the efficiency and reliability of power projects and microgrid installations. Over 90% of global electricity is produced via a turbine or rotating generator during the generation process. Gas turbine-powered combined heat and power systems provide efficient and adaptable solutions for major institutions such as hospitals, universities, and industrial complexes. Gas turbines are deployed both as high-efficiency baseload power solutions as well as backup generation capacity for renewable power systems, either alone or packaged together with electric storage systems. The CAPE consortium includes partners from across the gas turbine industry including multiple original equipment manufacturers, universities, national laboratories, utilities and other stakeholders who are working to develop a robust agenda of technology advances to improve the performance and cost structure of power and propulsion systems for global markets. Florida has an extraordinarily strong and vertically integrated industry of companies supporting the design, engineering, manufacturing, and service for power generation and propulsion systems, with thousands of employees and billions in revenue each year.

The presentation will review how Florida's advanced power and propulsion industry provides economic impact to the state. It will also highlight how the activities of the CAPE consortium coordinated by Energy Florida and other Florida-based institutions support the integration of smart grid, microgrids, storage and other technologies through implementation of combined heat and power and responsive capacity solutions.

Solar -6: New and Emerging Developments in Solar Energy

Yogi Goswami

Distinguished University Professor and Director, Clean Energy Research Center,

University of South Florida, Tampa, FL 33620-5350

Solar Energy can potentially play a very important role in providing most of the heating, cooling and electricity needs

of the world. With the emergence of solar photocatalytic oxidation technology, solar energy also has the potential to solve our environmental problems. This presentation describes some of the new and emerging developments, with special emphasis on:

(1) New concepts in Solar Thermal Power that have the potential to reduce capital costs by 50%;

(2) Solar photocatalytic oxidation for disinfection and environmental clean-up; and

(3) New Concepts in Direct Energy Conversion including plasmonic emitters for deep space radiative cooling.

The presentation will highlight opportunities for further research and development in the new and emerging concepts.

Solar -7: The Florida Alliance for Advancing Solar and Storage Technology Readiness

Rick Meeker[1], Amy Zubaly[2], Elaine Hale[3], Andrew Mills[4], John Wilson[5]

[1] Nhu Energy, Inc.; [2] Florida Municipal Electric Association; [3] National Renewable Energy Laboratory; [4] Lawrence Berkeley National Laboratory; [5] Southern Alliance for Clean Energy

This year, the Florida Alliance for Accelerating Solar and Storage Technology Readiness (FAASSTeR) is kicking off a 3-year project with support from the U.S. Dept. of Energy and participation and support of Florida's municipal and cooperative electric utilities to study and assist in developing pathways for successful expansion of grid-integrated solar, energy storage, and other distributed energy resources in Florida in a way that maximize value and reduce risk. The project scope includes performing Florida-specific studies and analysis and providing support to utilities, with the aim of enabling and increasing the overall value derived from solar, energy storage, and other distributed energy resources (DER) integrated into the Florida electric power system. The team, led by Nhu Energy, Inc, working closely with the Florida Municipal Electric Association (FMEA) and the Florida Office of Energy, also includes the National Renewable Energy Laboratory, Lawrence Berkeley National Laboratory, the Southern Alliance for Clean Energy, and Florida's municipal and cooperative electric utilities. This will provide an overview of the scope of the project, some information on the planned approach, and some insight into how FAASSTeR may foster a more renewable and sustainable energy future for Florida.

Solar -8: Power Electronics Applications in Renewable Energy

Muhammad H. Rashid

Fellow IET (UK), Life Fellow IEEE (USA)

Florida Polytechnic University, 4700 Research Way, Lakeland, FL 33805-8531, USA

Power electronics has developed continuously over the years and are finding increasing applications. There are many power converter circuits some of which have become standard topologies and are available as modules from the manufacturers. The demand for the development of environmentally clean, reliable and affordable energy technologies has prompted renewed interest in renewable energy systems worldwide. Many renewable energy technologies today are well developed, reliable, and cost competitive with the conventional fuel generators. The

renewable energy sources are generally converted to dc or ac electric voltages or currents. Many renewable energy technologies today are well developed, reliable, and cost competitive with the conventional fuel generators. The power electronics is finding increasing applications in renewable energy technologies to process efficiently and produce a flexible ac or dc output to match a variable or fixed load demand. This presentation reviews the chronological development of power electronic circuit and explains why power electronics is an integral part of energy storage and renewable energy systems for power conversion, transmission and distribution of electric power.

Solar -9: Encapsulated Phase Change Materials for High Temperature Thermal Energy Storage Media

Jaspreet Dhau

Department of Chemistry, Florida Polytechnic University, Lakeland, USA, FL-33805

Latent heat based thermal energy storage has definite advantage over the sensible energy based storage systems. Sensible energy storage systems require two tanks and large volumes because of low heat capacity of these materials. On the other hand, latent heat based storage system uses phase change materials (PCMs) that have high storage density, require single tank, and therefore, smaller volumes of storage. However, latent heat storage systems poses inherent problems that have prevented the commercialization of this technology. One of the biggest problems associated with this technology is the low thermal conductivity of the phase change materials, which is a concern, especially during a discharging cycle. We have overcome that problem by encapsulating the PCMs in spherical capsules. We have developed two approaches for the encapsulation of PCMs. In the first approach, solid nitrate ($NaNO_3$ and KNO_3-$NaNO_3$ eutectic) based PCM pellets were encapsulated with a chemically benign, selectively permeable, and flexible polymer coating which was supported by metal layer, deposited by a novel non-vacuum metal deposition process. In the second approach, chloride (NaCl and KCl-NaCl eutectic) based PCMs were encapsulated with low cost ceramic materials that could survive high temperatures ranging from 500 °C to 1000 °C. The results will be presented at the conference.

BREAKOUT SESSIONS - INVITED TALKS

ENERGY EFFICIENCY & SUSTAINABILITY ROOM 1067

JULY 31 – 02:00-04:00 AUGUST 01 – 09:30-11:30

Efficiency -1: Unique Energy Technology Partnership at NASA Kennedy Space Center – The TEST Hub (Transportation, Energy and Space Technology)

Tim Franta,

Director of Special Projects for Energy Florida, Melbourne, FL

The Transportation, Energy, and Space Technology (TEST) Hub is an innovative and groundbreaking partnership located at NASA's Kennedy Space Center (KSC) that supports community-scale testing and demonstration of next generation technologies across a range of applications. 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 developed this special relationship with NASA.

This presentation will discuss the advantages of having access to a world-class facility with more than 50 laboratories and workshops to test, evaluate and validate technology. This allows small and medium companies as well as researchers to have access to resources one could never afford as an individual. Current projects to be discussed include: testing of fuel cells, a US Department of Transportation-funded demonstration project of thermal electric generation for buses and trucks, and a US Department of Energy funded project developing insulation for vehicular hydrogen cryogenic storage tanks, among others. Laboratories and workshops include but are not limited to the following topics: chemistry and physics, electrical and electronic, fluids, mechanisms, and structures, information technology and communications, testing and analysis, and meteorology.

The Space Center is also an outstanding place to test systems because the Space Center is the size of a medium city in the United State but is a controlled and secured environment. The TEST Hub may be included as a resource for grant proposals as well. The presentation will emphasize the ability to access a $2 billion resource at reasonable prices and relative ease of access.

Efficiency -2: Smart" mechanical ventilation approaches for improved comfort, energy efficiency, and indoor air quality in homes

Eric Martin, Danny Parker, Karen Fenaughty, Dave Chasar, Charles Withers Jr.

Florida Solar Energy Center, 1679 Clearlake Rd, Cocoa, FL 32922

Smart mechanical ventilation systems balance energy consumption, comfort and indoor air quality (IAQ) by optimizing mechanical ventilation operation to reduce heating and/or cooling loads, improve management of indoor

moisture, and maintain IAQ equivalence according to industry standards such as ASHRAE Standard 62.2. Such systems ventilate more during periods that provide energy, comfort, and/or IAQ advantages and less during periods that provide a disadvantage. Mechanical ventilation operation may be controlled in response to individual or multiple control variables including outdoor temperature, outdoor moisture, and occupancy. This presentation will discuss results from simulations and laboratory home experiments conducted to investigate the benefits of smart ventilation algorithms and controls in Florida homes

Efficiency -3: The System Approach to Designing a Low Velocity Circulating System

Manny Garcia

Carrollwood Pools Inc., Tampa, FL 33606

"Science and the public have separated so much that many people in the public consider science just another option"- Alan Alda.

This document pertains to circulating water, particularly to swimming pools. It provide a viable global energy plan that has a multitude of energy efficient savings. It is based on lowering the hydraulic resistance within three designated modules of an integrated system.

The science begins with defining parameter values related to the hydraulic resistance and defining energy standards that applies to components, electrical consumption and configurations. An energy efficiency quotient is applied to all new and old pools.

Swimming pools waste too much electricity, too much chlorine, too much time cleaning and take too long to complete one turnover. Pressure gauges read too high, water whirlpools through skimmers, returns are too small and too little, while many components are placed in series.

Existing laws do not reflect new goals, standards, procedures, nor education, for developing a sustainable energy efficient plan. The industry is component oriented with many innovated products but none addresses energy efficiency as a totally integrated sustainable system where the components serve the system.

The world of low velocity circulating systems presents many discoveries of new products in the realm of energy efficiency. When the hydraulic resistance is lowered, the design of circulating systems takes on a new physical and functional form. A host of new products present themselves as well as the methods to make them.

Efficiency -4: Building a Net Zero Energy Campus and Culture at Florida Poly

Nicoleta Sorloaica-Hickman[1], Yassir Bello[1], Eric Rippe[1], Enrique Hernandez[1], Inna Kravchunovska[1], Robert Reedy[2]

[1]Florida Polytechnic University, Lakeland, FL 33805; [2]FSEC UCF, Cocoa, FL 32922

We present a feasible path to net-zero energy for the Florida Poly main campus that could be a model for other campuses. This includes on-site renewable energy installations combined with building energy and transportation energy savings. The analysis first focuses on climate factors, technologies and design considerations which can bring the campus to Net Zero Energy in the near future, then expand along with growth in facilities and student enrollment.

Then economic comparisons between energy efficiency and renewable energy generation are used to optimize the decisions taken.

Efficiency -5: Creative Partnerships for Sustainable Water Supply Solutions

Jason Mickel

Water Supply Section, Southwest Florida Water Management District

2379 Broad Street, Brooksville, FL 34604

The Southwest Florida Water Management District (District) encompasses roughly 10,000 square miles in all or part of 16 counties and serves a population of 5 million people in west-central Florida. The goal of the District is to meet the water needs of current and future water users while protecting and preserving the water resources within its boundaries. However, throughout the District and the State of Florida, there are many resource challenges associated with groundwater withdrawals including impacts to wetlands and surface waters, saltwater intrusion, reduced aquifer levels and limits to groundwater availability. In the District, population is expected to increase to 7 million by 2035 and demands for potable water are projected to increase to 1.5 billion gallons per day continuing to stress resources and challenge water managers.

This presentation will highlight collaborative regional partnerships to develop sustainable water supplies while protecting water resources. Two ongoing regional efforts include the Central Florida Water Initiative (CFWI) and the Polk Regional Water Cooperative (PRWC). Both efforts include a diverse group of partners and stakeholders working to meet current and future water demands through collaborative water supply planning, developing regional alternative water supply projects, expanding reclaimed water availability and implementing conservation options.

Efficiency -6: Evaluating moisture control of variable capacity heat pumps in mechanically ventilated, energy efficient homes

Charles Withers Jr., Eric Martin, Janet McIlvaine, Dave Chasar

Florida Solar Energy Center, 1679 Clearlake Rd, Cocoa, FL 32922

Building codes and high-performance building programs have resulted in tighter homes that depend more upon mechanical ventilation systems. Newer technology has brought very high efficiency variable capacity heat pumps to the residential market and can reduce heating and cooling costs by about 35%-40%. While heating and cooling costs are primarily focused upon by the industry, the costs to effectively address effective moisture control must also be considered especially in hot and humid climate zones. Effective moisture control is important because an average sized Florida home ventilated in accordance with ASHRAE 62.2-2013 will need to remove approximately 6 gallons of water from the ventilation air each day during summer conditions.

Air conditioning cools and dehumidifies air, but as the cooling load decreases, less moisture is removed and indoor air can become cool but humid. Elevated humidity decreases comfort and increases the potential for mold and mildew. Dehumidifiers may be relied upon to maintain acceptable humidity limits, but the annual dehumidifier energy use can exceed the annual energy use of higher efficiency air conditioning under certain conditions. Recent work has

evaluated how well different types of variable capacity heat pumps distribute air conditioning and control indoor humidity. This work will highlight specific challenges discovered in recent field and house lab studies and share opportunities to improve energy-efficient space conditioning.

Efficiency -7: A Thermodynamic Perspective on Energy Efficiency

Juan Ordonez,

Florida State University, Tallahassee, FL

In this talk we present different classical models for power generation systems from which efficiency limits have been derived and discuss the underlying model assumptions. Once this context has been elaborated, the talk focuses on the thermodynamic aspects of maximum power extraction from a hot stream. Thermodynamic optimization is employed to the case in which a collecting stream experiences a phase change to optimally allocate the available inventory of heat exchangers.

Efficiency -8: Politics, Messaging, and Energy Conservation Behavior of Municipal Utility Customers

Richard Feiock[1], Cali Curley[2], Kate Wassel[1]

[1]Florida State University, Tallahassee, FL; [2]Purdue University, Indian

We develop a political economy explanation for energy efficiency behavioral messaging by governments to citizens and advance hypotheses for message content. Using monthly messaging data from the City of Tallassee/ Tallahassee Utilities over a 67-month period, we apply text mining techniques and textual analytics to distill the content of messages to citizens. Empirical tests of our hypotheses messages linked to political, administrative and efficiency/ conservation motivations. We discuss the findings in relation to our previous work on how DSM programs influence residents' energy consumption, our ongoing NSF Sustainability Research Network and upcoming Smart and Connected Communities projects.

Efficiency -9: Why we need energy analyses in the NEPA process

David Keys, CEP (Due to time conflicts David Keys will not be presenting)*

Owner, Enviro-Limit-NEPA, Tarpon Springs, FL

"You have to decide whether you want to make money or make sense, because the two are mutually exclusive."
--Richard Buckminster Fuller, 1895 – 1983

Critical Path, 1981, p.225

This presentation will discuss my latest paper, "Assessing alternatives for sustainability: Quantitative analysis in NEPA," Environmental Practice, 19:1, 50-55 (March 16, 2017). It includes an updated concept of sustainability, identifies tenets of sustainability already existing in the National Environmental Policy Act (NEPA) of 1969, and calls for the use of energy analysis to evaluate the myriad alternatives generated by U.S. Federal agencies under the umbrella of the

National Environmental Policy Act (NEPA) of 1969 (P.L. 91-190). NEPA charges all Federal agencies to create alternatives to their proposed actions. Alternatives are not only the core of the environmental impact assessment (EIA) process, but also the boundaries of the decision space for Federal agencies. Sometimes, issue definition and clear basis for choice is missing in agency alternatives evaluation. Incorporating energy analysis into the equation may remedy this arbitrariness and lack of clarity. Alternatives creation and analysis is largely a subjective process relegated to the agencies that created them. Alternatives analysis must provide a clear basis of choice for making decisions, or NEPA's purpose is lost. In addition to reviewing the subjects above, this presentation will discuss different tools for energy analysis such as emergy, exergy, and energy return on investment (EROI). Evaluating alternatives with energy analysis may help ensure decisions make sense with NEPA's purpose and universal energy laws such as the Second Law of Thermodynamics—and provide a potential path to reach sustainability.

* David L. Keys, BS, MA, CEP is a forester, environmental policy practitioner, and board certified environmental professional in NEPA documentation with a military, federal government, consulting, research, and teaching background spanning four decades, including working for the U.S. Army and NOAA. He retired from NOAA, National Marine Fisheries Service, Southeast Region, Saint Petersburg, FL in 2014. In early 2015, he started Enviro-Limit, which is a Veteran Owned Small Business sole proprietorship located in Tarpon Springs, FL. Enviro-Limit specializes in providing science-based National Environmental Policy Act (NEPA) consulting services and environmental policy formulation services to Federal, state, and local governments and other organizations concerned with using the environment in a sustainable manner

BREAKOUT SESSIONS - INVITED TALKS

EDUCATION/WORKFORCE DEVELOPMENT

ROOM 1068

JULY 31 – 02:00-04:00 AUGUST 01 – 09:30-11:30

Education-1: FEEDER, A Distributed Technology Education/Research Center

Zhihua Qu

Department of ECE, University of Central Florida, Orlando, FL 32816

In this talk, activities of the FEEDER center are described. FEEDER, funded by Department of Energy), is a multi-institutional collaborative center to enhance power systems education at undergraduate and graduate levels and to pursue collaborative research. The talk will focus upon educational and research infrastructure that have been established as well as potential collaborative opportunities available.

Education-2: An off-grid zero emission building as a connecting block in sustainable energy conversion courses

Juan C. Ordonez

Department of Mechanical Engineering, Florida State University, Tallahassee, FL

This talk presents our efforts to utilize Florida State University Energy and Sustainability Center's Off-Grid Zero Emissions Building (OGZEB) as a common block in sustainable energy conversion courses. The OGZEB was built to serve as an energy efficient prototype for developing and testing cutting edge, sustainable energy technologies in both residential and commercial settings. This presentation describes the OGZEB energy systems and how they are used in sustainable energy conversion classes as examples, in homework problems, demonstrations, laboratories and projects. The exposure to sustainable energy technologies applied to a common familiar system (a house) provides motivation to the students and continuity to the course.

Education-3: Teaching a Fully On-line Renewable Energy Course

Muhammad H. Rashid

Fellow IET (UK), Life Fellow IEEE (USA)

Florida Polytechnic University, 4700 Research Way, Lakeland, FL 33805-8531, USA

For teaching a course specially a fully online course, where the lecturer does not have a face-face contact. Like a face-to-face course, there are similar issues of course syllabus, course outlines and topics, textbook, course learning outcomes and assessments, contemporary issues on renewable energy and broader issues and impacts such public

and pricing policies, smart-grid, ac versus dc, energy market place, energy efficiency, transmission and distribution, etc.

There are difference challenges in a fully on-line course such as security, cheating, plagiarism, answering questions and queries, office hours, ensuring a genuine student on the other on line. It usually takes much more class preparation than a face-to-face class and well-planned activities. However, it makes much easier for course assessment, grading and generating course statistics

This presentation shares the author's experiences in delivering a fully on-line 3-credit course, EEL 4283- Introduction to Renewable Energy. This course had been offering at the University of West Florida once in every year for the last 6/7 years. The class size had been more than usual, e.g. 65 enrolled in fall 2016. The author plans to share all online activities including the selection of text book and the turnitin plagiarism reports.

Education-3a: Specialization on Sustainable Energy Systems at UWF

Bhuvana Ramachandran[1] (will not be presenting at this conference) and Muhammad Rashid[2]

[1]University of West Florida, Pensacola, FL 32514; [2]Floria Polytechnic University, Lakeland, FL 33805

The specialization on "Sustainable Energy Systems" for Undergraduate Engineering students at the University of West Florida was created to educate the students about the ongoing transformation of the nation's generation portfolio from being heavily dependent on fossil fuels to one that is heavily dependent on renewables (especially wind and solar) and the need for operating competitive electricity markets.

The courses designed under this specialization are:

Required courses:

Future energy systems

Renewable energy systems

Sustainable power systems-Planning, operation and markets

Power electronics and drives

Elective course:

Environmental law

The University of West Florida (UWF) is a public university based in Northwest Florida with multiple instructional sites and a strong virtual presence. The Department of Electrical and Computer Engineering at UWF offers Undergraduate degrees in Electrical and Computer Engineering (ABET accredited) and professional development courses in Power and Energy Engineering to Gulf Power (GP), an electric utility owned by Southern Company. The management and supervisors at GP are very pleased with the technical content and delivery of these courses which is reflected from the fact that all students hired by GP from UWF have this specialization or are pursuing this specialization currently.

The student interest in this specialization is so high that every time one of these courses is offered, student enrollment exceeds the set limit. In fact currently (summer 2017), there are 76 students enrolled in the "Future Energy Systems" course. Upon successful completion of the program, the students have gained knowledge about the principles of sustainability management and the impact of climate change law on businesses and government, have the necessary skills and knowledge to make assessments and analyze and manage issues related to energy use, climate change and sustainability, and focus their career on clean energy.

Education-4: A systematic review on green architecture and educational environments

Negin Niroumand[1], Hamed Niroumand[2a, 2b], Charles Kibert[3], Mehdi Sharifi[4]

[1]Master Student, Department of Architecture, Islamic Azad University of Doroud, Doroud, Lorestan, Iran; [2a] Post-Doc, Vice-Chancellor for Academic and Research, Buein Zahra Technical University, Qazvin, Iran; [2b] Post-Doc, Powell Center for Construction & Environment, University of Florida, Florida, USA; [3] PhD, Professor, Powell Center for Construction & Environment, University of Florida, Florida, USA; [4] PhD, Department of Architecture, Islamic Azad University of Doroud, Doroud, Lorestan, Iran

In this review paper, it is tried to analyze the issues of sustainable architecture and green architecture through library resources and valid papers, after examining the standards of educational spaces with green architecture, designing schools with green architecture in the present ages is a particular importance because of its users which they are kids. Designing a green environment in an educational space can contribute to a great deal of green architecture and sustainable development. There are several articles about this topic which they are briefly described in this article. In this article, successful examples of green schools in all around the world are reviewed and analyzed their advantages. The results indicate that green architectural parameters which they are in the form of e green building in educational type according to global leadership standards such as: sustainable site, using water efficiently, atmosphere and energy, materials and resources, environmental qualities and priorities in a region. It is clearly known that designing green school (which most of users are children and students) are clearly familiar with the green architecture. During this process, Educational training programs on sustainability and environmental protection are included in the training program for these covers.

Keywords: green architecture, educational environments, green school, sustainable development.

Education-5: So Climate Chaos is a Hoax?

David E. Bruderly PE,

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The President of the United States has declared that Climate Chaos is a hoa and appointed an administrator of the US EPA who is working hard to deconstruct the "administrative state."

So what is a young scientist or engineer to do?

Drawing on 20+ years of business experience working in a political environment that has been hostile to environmental concerns and the use of innovative business practices and technologies to address these concerns, I will offer advice to younger scientists and engineers on how to not just survive, but prosper, in this hostile, anti-

science political environment.

Carpe diem.

Education-6: Renewable Energy Systems and Sustainability Education and Curriculum Development at Florida Polytechnic University

Sesha Srinivasan, Ryan Integlia, Jaspreet Dhau,

Florida Polytechnic University, 4700 Research Way, Lakeland, Florida 33805, USA

This energy 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 a technical elective. The proposed course "Renewable Energy Systems and Sustainability" (EEL 3287) is part of new discovery track of courses which was offered at FL Poly in the Fall 2016 semester. The course contents and industry led discussions covered a wide range of energy, sustainability and related applications, reflected 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 has created 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 course related research projects have been presented and demonstrated by the students at the end of the semester, for example, (i) renewable energy involving solar energy driven vehicles, (ii) flexible printed circuit boards, (iii) indoor air quality monitoring and (iv) waste water treatment via photocatalytic technology. This Florida Energy Systems Consortium (FESC) funded educational project has created 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. Continuation of this project incorporating other related topics in Green Chemistry, Engineering and Technology and Indo-US partnership with Panjab University will undoubtedly help the Florida Polytechnic University in establishing a Master's program on Applied Sciences and create a track in the field of STEM based research and also serve as a spring board to produce and solicit future grants for continuing education, research and outreach that will benefit our diverse students population and to the community.

Acknowledgments: Authors gratefully acknowledge the FESC for funding this Renewable Energy Systems and Sustainability educational project.

Education-7: BUILDING SUSTAINABLE CONNECTIONS THROUGH FILM SERIES

R. Madhosingh-Hector, H. Landis, and T. Ackerman

UF/IFAS Extension, Pinellas County, 12520 Ulmerton Road Largo, FL 33774

Situation: Film is an appealing storytelling approach that offers engaging visuals and thought-provoking ideas to lay the groundwork for meaningful discussion. By encouraging cross-county collaboration between UF/IFAS Extension Pinellas and the University of Tampa (UT), faculty sought to initiate sustainability discussions through film. Prior to

the film series, UT engaged in few sustainability efforts on campus. By reaching students, faculty, and members of the community, discussions were facilitated to provide feedback on their interests and concerns regarding the topics conveyed in the films. Methods: Faculty developed partnerships with local universities/colleges and utilized film screenings, moderated film panel discussions, a community expo, and retrospective evaluations to assess program design and delivery. Evaluations also collected suggestions on how UT could improve its sustainability efforts on campus. The film storyline included A Fierce Green Fire, Shattered Sky, Just Eat It, and Weather Gone Wild. Results: A total of 305 attended the film series with 152 returning evaluations. Attendees were asked if they felt that this format was more engaging and informative than a traditional lecture; nearly 77% felt it was more informative and 73% reported it being more engaging. Of those who returned the evaluations, 67% had no prior knowledge of Extension (n=102). When asked what UT could do differently, there were 12 comments about recycling, 27 about food waste and composting and 22 comments on how UT could improve its educational outreach of sustainability issues. Conclusion: Film screenings offer an innovative, non-traditional approach for Extension to assist, promote, and facilitate collaboration to engage community members, stakeholders, and institutions. As a result, UT has since adopted a "Recycling Resolution" to support and promote the University's recycling program, and is committed to resource reduction through its efforts on residence and dining halls.

Education-8: Circular Economy Paradigm for Sustainable Redesign of Introductory Laboratories

Scott Wallen, Cole Rittenhouse, Laura Wemple

Florida Polytechnic University, Lakeland, FL 33805

Today students in college and university curricula are quite aware and concerned of the need to reduce, reuse and recycle our material resources. Society and governments have supported many sustainable programs, legislation, products and processes for reasons ranging from resource conservation, reduced hazardous waste generation, economic and social incentives as well as potential for innovative outcomes (e.g. a new reaction product synthesized). In the design of the general chemistry laboratory curriculum aimed at young scientists and engineers, faculty have specific goals regarding the student learning outcomes for the laboratory course. These include demonstrating safe laboratory skills, applying problem solving skills to laboratory exercises, effectively communicate through written laboratory reports and utilizing scientific methodology including quantitative data analysis and interpretation. Ultimately the experiments are designed to complement and concretely illustrate the chemical principles introduced in the general chemistry lecture course.

Over the past 25 years there have been major strides in integrating individual experiments or courses that focus on green chemistry and sustainable, chemical principles. However, the typical general chemistry curriculum lacks a commitment to sustainable practices in the execution of the teaching laboratory experiments, the wastes generated and the opportunity to teach aspiring engineers and scientists a sustainable approach in what is often their first experience the laboratory setting. Several universities have focused on giving Green Certified Laboratory status to individual laboratories that have met specific criteria and on incorporation of green chemical principles in designing individual lab procedures. Keeping in mind that many instructors view green chemistry and sustainability as separate parts of the chemical curriculum and enterprise, the present work focuses on the redesign of the standard

introductory chemistry laboratory course from a sustainable point of view. This approach focuses on maintaining the pedagogical aspects of each experiment while conserving resources as well as reducing or eliminating waste. The circular economy concept provides a new paradigm in creating a circular laboratory and eventually circular laboratory curriculum. A key aspect of this redesign is to utilize wastes from one laboratory experiment as the starting material(s) for another experiment in the course or curriculum. The ultimate goal is producing zero waste and requiring only renewable starting materials. The redesign concept was awarded the 2016 Innovation Award of Commendation from the Campus Safety, Health and Environmental Managers Association (CSHEMA) and to date such an approach has not been reported in the scientific literature. The overall concept of this redesign will be presented with a focus on maintaining the learning outcomes of the original laboratory with the implementation of sustainable and recycling practices as imperative components. Specific experiments will be presented within this framework illustrating that this redesign concept saves both chemical and monetary resources, results in a significant reduction in the generation of hazardous wastes, and teaches future engineers, scientists and citizens' chemical principles as well as green chemistry and sustainable engineering practices.

Education-9: International Partnership and Course Curriculum Development on Green Chemistry, Engineering and Technologies

Jaspreet Dhau[1], Sesha Srinivasan[1], Ganga Ram Chaudhary[2], Rajeev Kumar[2], K.K. Bhasin[2]

[1]Florida Polytechnic University, Lakeland, FL, USA; [2]Panjab University, Chandigarh, India

The implementation of "Green Chemistry and Engineering Principles," and the development of "Green technologies" are paramount to our endeavor to ensure sustainable development of the human race. According to Anastas and Warner, "Green chemistry is the utilization of a set of principles that reduces or eliminates the use or generation of hazardous substances in the design, manufacture and application of chemical products." On the similar line, the field of "Green Technologies" embodies advanced group of processes and products, ranging from energy generation/ storage to biodegradable polymer products. The aim of this international collaborative partnership and project is to address the global challenges in the field of green chemistry/engineering and technologies and facilitate the development of an international educational curriculum, exchange of expertise research and outreach activities between the USA and India. The successful implementation of the project will be significant step in providing a platform to young scientists and engineers for designing and discovering the next generation chemicals and materials with enhanced performances and values while ensuring protection and strengthening human health and the environment. The project objectives are to develop a long term co-operative agreement between Florida Polytechnic University, Florida's first STEM based public University, and the Panjab University (a premier university, it is now amongst the first 10 Universities) in India, to execute and implement the respective institutional vision for creating green chemistry/engineering and technologies curriculum, research, education and outreach activities. The first international conference on Green Chemistry/Engineering and Technologies was recently organized at Panjab University, Chandigarh, India by the project investigators both from US and India in April 2017.

POSTERS SESSION
JULY 31 – 05:00-06:00
1ST SOUTH LOBBY 1ST FLOOR

Poster 01-Enhanced CO_2 conversion to CO by silica supported perovskite oxides at low temperatures

Bryan. J. Hare, Debtanu Maiti, Yolanda A. Daza, Venkat R. Bhethanabotla, John N. Kuhn

University of South Florida – Chemical & Biomedical Engineering Department

Efficient conversion of CO_2 to useful hydrocarbons is crucial for energy security along with a greener and better environment. Amongst the many established routes of CO_2 conversion, thermochemical based CO_2 conversion beholds great promise towards large scale application, the only limitation being its high operation temperatures (above 1000 °C). Our process, reverse water gas shift chemical looping (RWGS-CL), is capable of converting of CO_2 to CO at a low temperature of 600 °C using the $La_{0.75}Sr_{0.25}FeO_3$ (LSF) perovskite-type oxide. Using silica as a stable support, we hereby demonstrated unprecedented CO_2 conversion performance to CO. LSF-silica composites (25% LSF by mass) were found capable of enhancing the CO_2 conversion by 150% producing 1.7 mmoles of CO/g LSF. The composite was found to be stable over several cycles, with only a 20% decrease in CO generation rates. This improved activity of LSF is attributed to an optimum silica-perovskite molar ratio, reduced LSF crystallite size, wettability by silica, and controlled quantity of intermediates formed during high temperature sintering.

Poster 02-Low temperature CO_2 conversion to CO using earth abundant perovskite oxides

Debtanu Maiti, Bryan J. Hare, Yolanda A. Daza, Adela E. Ramos, Venkat R. Bhethanabotla, John N. Kuhn

Department of Chemical & Biomedical Engineering, University of South Florida, Tampa 33620

Repurposing of atmospheric carbon dioxide (CO_2) presents a novel approach for mitigating global warming and harvesting renewable energy. However, sustainable conversion of CO_2 remains a challenge till date. Most of the current existing protocols for CO_2 conversion techniques are plagued by several limitations like poor rates of conversion, high operation temperatures, unstable catalysts, use of costly noble metals, etc. Solar thermochemical (STC) approach has garnered attention in recent times due to its high rates of CO_2 conversion and use of stable materials like perovskite oxides. However, its high operation temperature (above 1000 °C) still limits its applicability in large scale. Reverse water gas shift chemical looping (RWGS-CL) process is a modified form of STC, whereby CO_2 can be converted to CO at even better rates than STC at lower temperatures (~500 °C). The underlying phenomena of RWGS-CL revolves around creating oxygen vacant materials under hydrogen and thereby using these oxygen-deficient materials as platforms for CO_2 conversion. Henceforth, we predicted several perovskite oxides of the form (ABO_3, $A1_{0.5}A2_{0.5}BO_3$, $AB1_{0.5}B2_{0.5}O_3$, and $A1_{0.5}A2_{0.5}B1_{0.5}B2_{0.5}O_3$) with potential capability for CO_2 conversion using DFT-calculated oxygen vacancy formation energy as a key descriptor. These materials were synthesized via Pechini method and subsequently tested for CO_2 conversion performance. Lanthanum and calcium based materials demonstrated the highest CO_2 conversion rates at lowest temperatures of (450-500 °C) using RWGS-CL. Stability over several cycles and their relatively high earth-abundance makes these perovskite oxides potential candidates for sustainable industrial

implementation. Conversion of CO_2 at these low temperatures allows for thermal integration of RWGS-CL process with subsequent Fischer Tropsch (FTS) reaction for the generation of useful hydrocarbons from CO_2.

Poster 03-24-h day novel passive radiative cooling of buildings using clear sky radiative coolers

Mehdi Zeyghami, D Yogi Goswami, Elias Stefanakos

Clean Energy Research Center, College of Engineering, University of South Florida, 4202 E. Fowler Avenue, ENB118, Tampa, FL33620, USA

Efficient building cooling and dissipation of low grade heat from industrial applications has been an energy challenge. Active cooling of buildings is energy intensive and the primary reason of seasonal and daily electricity demand peaks. Clear sky radiative cooling is shown to be an effective option for passive building cooling and reducing the global cooling energy demand. A radiative cooler uses the transparent atmospheric window to emit heat to the outer space without any external energy and fresh water input. Nighttime radiative cooling has been studied widely and successful results has been demonstrated before. Although, the building cooling loads peak at daytime when solar irradiation is present. Also thermal coupling between the building and the cooler is still a challenge.

We have designed two types of radiative coolers made of one-dimensional photonic structures. The first design uses an aluminum back reflector covered with alternating thin layers of Al_2O_3 and SiC as the emitting parts. Such a cooler can be integrated with the opaque surfaces of the building envelope. The incident solar radiation is reflected by the back reflector and the emitting parts dissipate the heat passively. The second design that is a novel approach is a semi-transparent cooler that is made of alternating thin layers of SiO_2 and SiC on top of a transparent substrate. The semi-transparent cooler allows the solar radiation to pass through the structure with minimum absorption and at the same time emits strongly at atmospheric transparency window. The semi-transparent window can be integrated with building windows and remove the heat from the building passively. Theoretical cooling performance calculations of designed passive coolers show up to 50 W/m^2 cooling power and up to 1kWh/m^2 daily cooling capacity.

Poster 04-Ultra-Efficient PV Assisted Heat Pump Water Heater with Increased Energy Storage

Carlos J. Colon and Danny Parker, FSEC-UCF

The project showcases a novel solar photovoltaic-assisted heat pump water heater (PV-HPWH). The system integrates a 50-gallon HPWH with two 310 Watt photovoltaic (PV) modules, microinverters and smart controls to produce and store hot water. Total system cost fares notably well, with great reliability and excellent performance during cloudy weather. Moreover, it makes for a simple installation with two modules and prevents feeding electricity into the grid (net metering). The HPWH controls have been modified using IoT communication devices such that higher tank temperatures are stored during the day when solar availability is abundant. It achieves very high efficiencies by extending daytime compressor operation up to its maximum compressor water heating setting (140 ^{0}F). The controls evaluate solar electric energy production in near real time and automatically change thermostat settings. When thermostat temperatures are satisfied, the remaining PV electricity is stored in the tank in the form of heat by using a staged electric resistance heating element. Typical performance sees hot water storage greater than 146^{0}F

at sunset. A mixing valve limits hot water to the end user at a target baseline temperature of 125^{0}F. By altering tank temperatures above the baseline level, an equivalent of ~2 kWh of electrical energy is stored for use during evening hours preventing the use of electricity. The system has been tested for more than a year in a laboratory at the Florida Solar Energy Center (Cocoa, FL). Realistic hot water draws were imposed with detailed data recorded on system performance. Long term average monthly efficiencies (COP) have been greater than 4.5 and as high as 7.0 during sunny summer. Average daily grid electricity consumption has been 1.2 kWh/day – less than many refrigerators.

Poster 05-AspenPlus™ simulation of stack electro-reactor for the conversion of CO_2 and H_2S to CH_2O_2

Chidinma P. Ohagwa[b], Rekisha A. Pootoon[a], Alan Daou[a], Jonathan C. Mbah[a],

[a]Department of Chemical Engineering, Florida Institute of Technology, Melbourne, FL 32901

[b]Department of Computing, Florida Institute of Technology, Melbourne, FL 32901

A 17.2 kW polymer electrode membrane electrolytic cell (PEMEC) stack is modeled for the conversion of CO_2 and H_2S feedstock to mainly formic acid (CH_2O_2) and elemental sulfur in AspenPlus™ simulation model V9 software. The cell operates at a moderate optimum pressure of 3 bar and at 120°C, a temperature at which sulfur is a low viscous fluid and can flow out of the electrolytic cell without hindrance. The economics of this process rely heavily on power and electrolyzer stacks. When dealing with electrolysis, optimization of these two parameters is needed. To perform this optimization, we utilize the best configuration used in our material balance analysis: current density of 6.098 A cm-2 at a cell potential of -1.238 V. The results indicate that there should be a balance between voltage and current density with respect to feed utilization and temperature should be operated at above 60% and above 100°C values respectively. Temperature has significant impact on the current density as a result of increase in the cells kinetics. Thus, system efficiencies are expected to improve with temperature. However, this increase must be limited to temperatures at which sulfur is a low viscous fluid between 120 – 145°C.

Poster 06-Design and Manufacturing of Electronic/Ionic Conductive Polymer for Solar Fuel Devices

Ibtehai Alshdoukhi and Michael Freund

Department of Chemistry, Florida Institute of Technology, Melbourne, FL 32901

There is global interest in the manufacture of an artificial photosynthetic systems which mimic the properties of the thylakoid membrane found in natural photosynthesis systems. However, a significant amount of research is still required to determine the characteristics of membranes that can be potentially used in creation of these systems. The research described will include the manufacture of composite bipolar membranes that have the potential to be incorporated in artificial photosynthetic systems. Effective bipolar membranes can help by establishing an optimum pH difference between the oxidation and reduction reactions taking place in membrane-based systems. Key performance characteristics include good electronic and ionic conductivity. The findings of this study can help in manufacturing, utilization and evaluation of such a bipolar membrane for commercial use.

Poster 07-Economic and environmental life cycle assessments of solar water heaters applied to aquaculture in the US

Youngwoon Kim, Qiong Zhang

Department of Civil and Environmental Engineering, University of South Florida

Fowler Ave ENB 118, Tampa, FL 33620, USA

Global aquaculture production has increased rapidly over recent decades, playing an important role in serving an essential protein source for world population. Understanding and mitigating its resource use and environmental impacts are important for the sector to grow in a sustainable manner. As a renewable resource, solar energy has been considered to reduce energy burdens as well as environmental impacts of fish farming practices. This study aims to investigate the applicability of solar water heaters under different geographical conditions (cold, moderate and hot climates) with consideration of both environmental and economic impacts. In addition, various operational strategies and design factors were considered including water sources (groundwater or streamwater), heating amounts (partial or full support) and solar system designs (horizontally or optimally oriented solar panels). Energy requirement was estimated based on a recirculating aquaculture system for Nile tilapia production under indoor and outdoor conditions. Instead of energy savings, the potential economic improvements due to the temperature effect on fish yields were considered as an economic benefit of using solar water heaters for aquaculture. The results of Life Cycle environmental Assessments (LCA) showed that a 50% heating strategy was a threshold for all cases, except for hot climates, because normalized environmental impacts greatly decreased with 20% to 50% heating strategies, then no significance difference was observed with additional heating. Similarly, a 50% heating strategy was also a threshold for economic feasibility in Life Cycle Cost Analysis (LCCA), except for the indoor systems in the moderate climate. With the variations of heating demands and efficiencies of solar systems, the considerations of water sources and solar system designs could further mitigate environmental and economic impacts depending on local conditions. This study can provide insights to the optimal operational strategies of the solar water heaters for aquaculture to seek environmentally and economically sustainable energy systems.

Poster 08-Simultaneous Identification of Building Dynamic Model and Occupant-Induced Load

Austin Coffman, Prabir Barooah

Dept. of Mechanical and Aerospace Engineering, University of Florida

A model of a building's thermal dynamics is needed for prediction-based control. The task of identifying a thermal dynamic model is made challenging by the presence of large unmeasured disturbances, especially the heat gain due to the occupants. In fact, identification of this occupant-induced load is also valuable for predictive control and has received little attention in the literature. We propose a method to identify both a dynamic model and the unmeasured disturbance from measured data. The method is based on a thermal resistance capacitance network for the building dynamics and the assumption that the occupant-induced load is piecewise constant for the internal disturbance dynamics. Coupled together, these dynamics form an augmented model that can be used for parameter estimation and state re-construction (internal disturbance estimation) through filtering techniques. The effectiveness of the method is evaluated using data from a simulation model (under both open and closed loop operation) and a real

building. A way to evaluate the method with real building data, which is challenging due to the lack of a ground truth, is also presented.

Poster 09-Effects of Biosolids Addition and Alkalinity Sources on High-Solids Anaerobic co-Digestion of Food Waste and Green Waste

Phillip Dixon[1], Eunyoung Lee[1], Paula Bittencourt[2], Eduardo Jimenez[1],

Meng Wang[1], Qiong Zhang[1], and Sarina Ergas[1]

[1]Department of Civil & Environmental Engineering, [2]Department of Mechanical Engineering, University of South Florida, 4202 E Fowler Ave, Tampa, FL 33620

High solids-anaerobic co-digestion (HS-AcD) of the organic fraction of municipal solid waste (OFMSW; e.g. food waste [FW] and green waste [GW] also known as yard waste) with biosolids (waste sludge from municipal wastewater treatment) has a number of potential benefits. These include faster waste degradation and higher biogas methane (CH_4) content than conventional or bioreactor landfills, lower water use and leachate production compared to liquid anaerobic digestion, and production of a nutrient rich compost fertilizer product. HS-AcD of mixtures containing FW can result in rapid production of volatile fatty acids (VFAs) as sugars as fatty acids are broken down. Inhibition of microbial CH_4 production occurs due to both VFA toxicity and low pH. The addition of a solid phase alkalinity source to the reactor's contents, such as limestone or oyster shells, can buffer pH swings. Using biochemical methane potential (BMP) assays and life cycle cost analysis (LCCA), this study investigated how the addition of biosolids and alkalinity sources affect bioenergy production and the economic sustainability of FW and GW HS-AcD. BMP reactors were set up and biogas production, CH_4 content, TS, VS, and leachate pH, alkalinity, ammonia, and VFAs were measured. Using the present value method, an LCCA was carried out for a full-scale HS-AcD scenario in Hillsborough County Florida, with and without biosolids and alkalinity source addition. The results showed that although the addition of biosolids decreased CH_4 yields, overall CH_4 production and economic sustainability increased due to greater availability of organic substrate for biogas production and lower tipping fees. Addition of either limestone or oyster shells improved CH_4 yields; however, oyster shells were the lower cost alkalinity source option. In conclusion, this study provides information on the economic sustainability of renewable energy production from OFMSW and biosolids.

Acknowledgements: Funding for this research was provided by the William W. "Bill" Hinkley Center for Solid and Hazardous Waste Management. Additional support came from the National Science Foundation under Grants No. 1243510 and 1156905. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the Hinkley Center or the National Science Foundation.

Poster 10-Life Cycle Assessment for Microalgae Bioenergy Production coupled with Wastewater Treatment

Eunyoung Lee & Qiong Zhang

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As the discharge limits become more stringent, wastewater treatment plants (WWTPs) require a large amount of energy to remove nutrients from influents. An integrated microalgae system with the WWTP is a promising option to achieve nutrients and energy recovery while mitigating carbon dioxide (CO_2) emissions. In the integrated system,

a microalgae cultivation system can treat wastewater through nutrient uptake by microalgae so that the WWTP can reduce external energy consumption and on-site CO_2 emission during wastewater treatment. In addition, the harvested microalgae biomass can be used as a feedstock for anaerobic co-digestion with waste sludge to improve biogas production in the WWTP. Despite of the advantages, the sustainability of the integrated system, however, has not been fully understood. Therefore, this study investigated the sustainability of the integrated system through life cycle assessment approach, focusing on potential life cycle impacts from carbon, energy, and nutrient perspectives. Also, the life cycle impacts were compared to the conventional WWTP. The integrated systems reduced the carbon footprint and cumulative energy demand when compared to the conventional WWTP, because of the reduction of CO_2 emissions and electricity demands as well as the increased energy production from the anaerobic co-digestion. However, there was no significant difference in the nutrient-related environmental impact (e.g. Eutrophication) between the integrated and conventional systems due to their equal effluent qualities. In summary, the integrated system was not able to achieve carbon, energy, and nutrient neutralities, but the system considerably improved the energy balance via the reduction of electricity demands from wastewater treatment processes and the increase of energy production from the anaerobic co-digestion.

Poster 11-Round-trip efficiency of an HVAC-based virtual battery

Naren Srivaths Raman and Prabir Barooah

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With greater penetration of renewable energy sources, balancing supply and demand has become challenging as these sources are volatile and uncontrollable, so there is a need for a large amount of ancillary services to maintain this balance. Among such services Heating, Ventilation and Air Conditioning (HVAC) systems in commercial buildings have huge potential due to their large power consumption and thermal inertia. In the recent past, there has been a lot of research on using buildings as a virtual battery (VB). Like any other energy storage system there is an efficiency involved in using buildings as a VB. In this work we characterize the round-trip efficiency (RTE) and the range of values it can take. Prior work has reported very low values for RTE, which will make this technology uneconomic. Here we show that those low RTE values were a result of the way the experiments were conducted. We show that RTE in fact can be made much closer to 1, indicating that using buildings as a VB can be an economical competitor to real batteries and other resources.

Poster 12-Simultaneous identification of building dynamic model and disturbance using sparsity-promoting optimization

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Accurate thermal building models, as well as the unmeasured disturbance, are valuable for controlling HVAC system to be more energy efficient. We propose a method for identifying thermal building models for HVAC control in the presence of large, unmeasured disturbances. In addition, the method also identifies the effects of those unmeasured disturbances on the output.

Our method uses l1-regularization to encourage the derivative of the identified scaled disturbance to be sparse, the motivation of which is physically meaningful. We use regularization parameter selection method, which will automatically search the optimal penalty parameter that balances two components of the cost function errors. Meanwhile, constraints based on physical properties of the thermal building models and each input are introduced in order to increase identification accuracy.

We test our method using training data from both open-loop and closed-loop simulations. Results show that the identified model can accurately identify the transfer functions from flow rate and supply-air temperature to room temperature in both cases, even in the presence of large, unmeasured disturbances, which makes it valuable for MPC applications.

Poster 13-Dielectric Spectroscopy of Epoxy-Based Composites Filled with Phosphatic Clay and Diatom Frustules

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Diatoms are algae known for their porous frustules of amorphous silica. They have shown potential as the disperse phase in a high capacitance composite. Recent research has also shown that clay has probable capacitive properties that may be exploited for high temperature capacitor applications. The phosphatic clay used in the investigation is a phosphogypsum deposit found in Florida settling areas that has no use in agriculture. A long term potential goal is to assemble a supercapacitor as a clay/diatom composite; hence, an understanding of their individual dielectric properties is helpful for design purposes. The phosphogypsum was supplied by Mosaic-South Fort Meade, and the diatom frustules were obtained from 100% food grade diatomaceous earth. The composites were prepared by combining an epoxy with the fillers at 10:1 ratio. An LCR meter was used to measure the capacitance and dissipation of the coupons at multiple frequencies, from which the dielectric properties were calculated. The results showed that at 100 Hz, coupons of plain epoxy, epoxy/clay, and epoxy/diatom had average dielectric constants of 6.1, 6.5 and 6.1, respectively. The Maxwell-Garnett model was used to elucidate the dielectric constant and the dielectric loss factor of the phosphatic clay and diatom themselves. The values obtained were 7.1 and 6.1, respectively for dielectric constant, and 0.36 and 0.31, for dielectric loss factor, respectively. These values suggest that phosphatic clay is possibly composed of dolomite (dielectric constant ~7.4) and the diatom frustules' dielectric properties are close to an amorphous silica (~4.5), both of which are good candidate materials for energy storage applications.

Poster 14-HfB_2, ZrB_2 and $Hf_{0.5}Zr_{0.5}B_2$ Solid Solution UHTC Ceramics: Processing by SPS and Mechanical Properties

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Keywords: Ultra High Temperature Ceramics, SPS, HfB_2, ZrB_2, $Hf_{0.5}Zr_{0.5}B_2$, Ring-on-Ring

Ultra-High Temperature Ceramics (UHTC) are refractory materials that can be used as coating for components that are exposed to high temperatures, such as power systems that concentrate solar energy. Mechanical properties of Spark Plasma Sintered (SPS) HfB_2, ZrB_2 and their $Hf_{0.5}Zr_{0.5}B_2$ solid solution were studied both at room and high temperatures. For SPS, 300g of pure HfB_2 and 300g of pure ZrB_2 powders (starck grade B) were ball milled in a planetary ball mill for 6 hours. To make 50/50 Hf-Zr-B solid solution, 150g of pure HfB_2 and 150g of pure ZrB_2 were also ball milled together for 6 hours. WC 250ml lined vial and 5-10mm in diameter SiC balls were used for milling in the ethanol as a liquid media. After the batch preparation, pure HfB_2 and ZrB_2 samples were sintered at 2100°C, while $Hf_{0.5}Zr_{0.5}B_2$ solid solution was densified at 5 different temperatures between 1900°C to 2300°C in order to determine the optimal temperature for its densification. After sintering of 21mm in diameter and 6mm in thickness pellets, the samples were machined into 20mm in diameter and 2mm in thickness disks, which were further used for the study at room and high temperatures of the properties by Resonant Ultrasound Spectroscopy. The Young's, shear and bulk moduli, along with Poisson's ratio were measured up to 1000°C. At the same time, an attempt is being made to measure the biaxial strength of these ceramics using ring-on-ring biaxial strength testing technique. In order to accomplish the measurement, the ring-on-ring testing jig was designed and manufactured, and it is currently being validated to obtain the biaxial strength of HfB_2, ZrB_2 and their 50/50 solid solution.

Poster 15-Performance Analysis of Low Grade Solar Heat Powered Supercritical Organic Rankine Cycle for Cogeneration Applications

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Availability of clean drinking water and power are two important issues in the world. In this paper, an innovative new design of multi effect desalination coupled with mechanical vapor compression (MED-MVC) powered by supercritical organic Rankine cycle utilizing a low grade solar heat source using evacuated tube collectors is analyzed. The supercritical organic Rankine cycle efficiency is about 14% at 150°C and 5MPa with R152a as the working fluid. The advantage of using a SORC as opposed to a subcritical ORC is that the heating process does not go through the two phase region, creating a better thermal match in the heat exchanger with less exergy destruction and ultimately a higher cycle efficiency. LT-MED, where the top boiling temperature is less than 90°C, reduces fouling and scaling in the effects common in standard MED systems. MVC has a high efficiency and is more reliable when compared with other vapor compressors. The proposed innovative design has the potential to desalinate water of high salt concentrations with low energy consumption and high efficiency when compared with the previously discussed systems. The performance of the LT-MED-MVC was found to be better than similar systems found in the literature. The specific power consumption for MVC is lower than 1 kWh/m^3 for seawater feed salinity of 42,000 ppm, 14 forward feed effects, and a recovery rate of 50%. The overall system efficiency is 11%. The impact of increasing the number of effects on the performance ratio, effect specific area, specific power consumption, solar collector area, and the system efficiency are also analyzed.

Poster 16-Thermal/Hydrodynamic Study of Novel Solar Powered Thermal Desalination

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In remote communities, simultaneous electrical power generation and production of potable water is an attractive solution to reduce/eliminate the high transportation cost for fuel and water. Desalination is an energy intensive process, which highlights the need to find suitable alternative energy resources for the desalination systems. Current research shows that solar/desalination hybrid systems incorporating thermal storage are more economical and could overcome the intermittence of solar energy. The proposed system is a combination of a multi-effect desalination with vapor compression (MED-VC) and organic Rankine cycle (ORC) driven by a parabolic-trough collector (PTC).

An innovative thermal process in MED-VC can enable the development and commercialization of small scale power generation and potable water production for remote regions worldwide where seawater and sunlight are available. Enhancement of heat exchange surface is required to have compact and economical evaporators which are critical for the production of potable water without the need for expensive pre-treatments. In the present novel design, a multilayer of concentric cylinders (MCC) is proposed to solve the high capital cost issue while maintaining high energy efficiency. The new approach could offer a MED system that is 10~20 fold more efficient than traditional MEDs by utilizing the characteristics of boiling and condensation on vertical plate falling film heat exchangers. Surface enhancements on both sides are used to ensure fully wetted exchange surfaces and prevent creation of dry zones.

A dynamic model is developed based on solving the conservation equations of mass, energy, and salt. The model has been validated with published experimental data. It is used to predict the MED system output behavior under different transient input conditions and optimize the plant control system. Furthermore, two six-kW pilot systems (single and three layers of effects) with compact design will be studied experimentally to test the validity of the innovative design for lower cost desalination.

Acknowledgements: I am thankful to Prof. Louis Chow, Prof Osama Mesalhy and my colleague Ramy Abdelhady for their continuous support and guidance. Also, I would like to extend my sincere appreciation to the Department of Energy for funding of this research through the Grant No. DE-SC0015809.

Poster 17-Pure Algae Growth Systems: A novel technology for large scale algae feedstock production

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Introduction:

The majority (90% +) of commercial algae growing systems are open to the environment and mimic nature's pond growth (open raceway ponds). These promote a struggle for "survival of the fittest". Frequently wild algal strains or predators are introduced which destroy the pure strain culture desired by most commercial installations. Water and land use demands for large scale biomass feedstock production in open raceways are economically unrealistic. A number of smaller closed systems include indoor batch systems using fermentation. Current closed-loop photo-

bioreactor systems are severely limited in flexibility and the capability to modify the temperatures and pressures in the actual growing media. Such limitations hinder scale up to the extent that commercially viable production rates have stalled for lack of innovation. The Pure Algae Growth System (PAGS) process eliminates the critical shortcomings of current commercial algae growing technology.

Technology Description:

The proposed process technology will improve the way algae is grown. It accomplishes this by totally protecting the growing media, cleaning all incoming materials that contact the media, and providing optimal growing conditions for the specific algae strain grown. The system comprises a pressurized mixing and recycling chamber, pressurized modular transparent flexible light reactors (100mm I.D. x 100 meters Length), and a liquid pumping system capable of circulating the algal culture in turbulent flow greater than a Reynold's number of 10,000. The pressurized mixing chamber ensures that inputs (macro- and micronutrients, fresh medium, and makeup water) are efficiently and homogeneously distributed throughout the entire system. Additionally, the chamber allows efficient introduction of CO_2 and removal of excess oxygen. It provides pressure needed to drive the algal culture into the modular light reactors and through the entire loop for return to the mixing tank. It recycles all unused materials resulting in significant efficiency improvements in almost all categories. The result is a dependable, robust system/facility providing a predictable algae biomass output at a known cost.

The Pure Algae Growth System technology is designed to ensure high feedstock growth rates, predictable growth cycles, and almost total immunity from outside contamination. The system is engineered for the purpose of growing selective monoculture algae in a safe, convenient and economic manner. Unlike open raceway ponds, this novel system offers a closed environment where outside influences are virtually nonexistent. Materials such as nutrients, diluents, and carrier media are carefully screened and cleaned to an almost sterile condition. Factors such as nutrient concentration, temperature and chemical levels are all optimized for the growth of a specific algal species.

Due to the tightly controlled design, the system is well-suited to the large scale growth of single algae feedstock for high value applications and food grade material. The reverse benefit is scaled-up growth of GMO algae grown for a specific end-product. Modified algae strains are securely contained within the closed PAGS process without risk to native species. Modifications can be made to ensure that the end use of the microalgae feedstock is taken into account. All requirements of the cultured species are met including specific growing conditions such as nutrients and light. Other modifications involving the type of dewatering required, uses of

non-potable water, waste waters, addition of fixed carbon substrates or use of industrial carbon dioxide emission can be added without operational risk.

The PAGS sanitary process eliminates species "crash" due to algae species predators as is common in ORPs. With PAGS, predators can't get in. Only pure monoculture algae is grown; the resulting biomass is ready for downstream processing. ORPs cannot approach the security or sanitation offered by PAGS. Eliminating the risk of algae media contamination from foreign entities reduces production cost while increasing algae biomass yield. The techniques and equipment employed are widely known in pharmaceutical and microelectronic manufacturing.

Pure Algae Growth Systems (PAGS) bypasses the shortcomings of open raceway ponds (ORPs). The system is based on typical chemical engineering procedures associated with successful plant design and operations. Algae growth

rates are higher in continuous systems utilizing central functions to control and support additional production operations. Batch systems (all ORP algae growth systems) cannot realize these benefits. However, ORPs are the dominant technology in commercial algae production. Compared to ORPs, PAGS reduces land use via its compact design, 24/7/365 grow / harvest capability and innovative flexible PBR tubing in 100 meter "runs". Our 8 acre facility is designed to out-produce ORP farms sitting on over 5000 acres.

PAGS significantly reduces the amount of water used in processing and harvest. Over 95% of the water is recycled and reused. ORPs evaporate a large portion of their water each day causing frequent, expensive replenishment. PAGS design provides efficient utilization of nutrient inputs. Carbon dioxide and other nutrients are introduced to the liquid media under pressure thereby making them continually available to the algae. The system is designed for change-over in only minutes from photosynthesis to heterotrophic growth modes. PAGS grows algae at night, ORPs cannot. With its many inherent system engineering, cost, land and resource use benefits versus ORPs, PAGS is poised to become the dominant algae biomass feedstock production platform.

Summary:

The PAGS process technology has the potential to radically disrupt the way algae is grown and used. The biomass feedstock industry continues its long-running struggle to achieve large-scale algae growth without utilizing an economically excessive quantity of land, water and nutrient inputs. The proposed process system is designed for species control, optimal growth rates and maximum economies of scale. Potential impacts in the near-term include using PAGS for the production of high value items such as foods, nutraceuticals or APIs. Producers of end-products will benefit from stable supply and the lowering of feedstock prices. As the feedstock market evolves and supply increases, the lower cost of algae feedstocks will make commodity products such as biofuels an attractive possibility.

Plant Size	Biomass Output	System Capacity	Tank (Liters)	Circulation PBR (Liters)	Photo-bioreactor PBR (Meters)
DEMO	1 MT / YR	11K Liters	7K	4K	500
1SGM	4 MT / YR	23K L	15K	8K	1,000
10SGM	40 MT / YR	230K L	150K	80K	10,000
100SGM	400 MT / YR	2300K L	1.5M	800K	100,000

Plant Size	Biomass Output	CAPEX	OPEX	Site Size	Site Size
DEMO	1 MT / YR	$2,250,000	$340,000	1200 M^2	50'x250'
1SGM	4 MT / YR	$5,000,000	$1,300,000	12K M^2	3 acres
10SGM	40 MT / YR	$10,000,000	$2,700,000	32K M^2	8 acres
100SGM	400 MT / YR	$20,000,000	$5,400,000		

Biomass	Cost AFDW	Cost	Cost	
Plant Size	Output	$ / KG	$ / LB	$ / Ton
DEMO	1 MT / YR	$340	$154.55	$309,091
1SGM	4 MT / YR	$325	$147.73	$295,455
10SGM	40 MT / YR	$68	$30.68	$61,364
100SGM	400 MT / YR	$43	$19.55	$39,091

Poster 18-Membranes for Renewable Energies

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This work describes the use of a benzimidazolium-based anion exchange membrane for creating bipolar membrane, BPM, and assesses its suitability for solar-driven water splitting. The role of the interface on the efficiency of water dissociation, and also optical properties of the new BPM was also investigated. The BPM was prepared by laminating the anion exchange membrane with Nafion membrane without the addition of any binder in the interface. The fabricated BPM has average thickness of 90 micrometers (vs. ca. 200 micrometer in commercial BPM) and shows low voltage loss and high light transparency. The findings suggest that the two membranes create a sharp hydrophilic interface with a space charge region of only few nm, thereby generating a large electric field at the interface that enhances water-dissociation. The fabricated BPM could have potential applications in many devices including fuel cell, and carbon dioxide reduction systems.

Poster 19-Modelling of energy intensity in aquaculture: Change in energy use in the global aquaculture with climate change

Youngwoon Kim, Qiong Zhang

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Global aquaculture production has been increased at an impressive rate over the past decades, playing an important role in serving as an essential protein source for world population. Understanding and mitigating its resource use and environmental impacts are important for the sector to grow in a sustainable manner. Aquaculture is a highly diverse activity which can be categorized by aquaculture factors of culture species, culture system, and technology. Energy intensity of aquaculture can be explained by the aquaculture factors as well as local condition. This study aims to investigate the effects of the aquaculture factors and local condition on the energy intensity of aquaculture using a generalized regression model. All considered factors in the model were statistically significant and no violations of major assumptions needed for the generalized regression model were suggested. A limitation of the model was described and a possible solution was discussed. The established energy model was used to estimate energy use in the aquaculture sector by analyzing the current global aquaculture distribution. The results of energy analysis on the current global aquaculture were also discussed in terms of a production scale and a geographical location (developed

and developing regions). Moreover, the model was applied to investigate the effect of global climate change on energy use in the future aquaculture sector. For this, five different growth scenarios of the aquaculture sector were developed, including "as usual, faster expansion, slower expansion, increased demands in China, and innovative and environmentally friendly". With the climate change effect, each scenario was investigated and compared in terms of energy use. Keywords Global aquaculture, Energy model, Sustainability, Climate change, and Energy efficiency.

Poster 20-Enhanced Adsorption Cooling System Using Monolithic Nanoporous Adsorbents

Ramy Abdelhady

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Adsorption cooling is an alternative technology to vapor compression air conditioning. It is powered by solar energy or low-grade heat, and uses environmentally friendly refrigerants such as water. The sorption bed (adsorbent) is the core of an adsorption cooling system in which the refrigerant (adsorbate) is adsorbed/desorbed to compensate the work needed in conventional vapor compression cycle. Equilibrium uptake/capacity of the adsorbent and fast thermal response of the bed are key factors for high performance. Packed beds, which suffer from low thermal conductivity due to poor particle-to-particle contact and poor particle-to-cooling surface contact, are regularly used in such systems. In this research, an experimental setup is built to measure the kinetics and the equilibrium uptakes of any adsorbate/adsorbent pairs under real operating conditions. Equilibrium uptakes of silica-gels are measured at various pressures and temperatures. The maximum uptakes of silica-gel RD-2060 and RD are found to be 0.38 kg/kg and 0.48 kg/kg, respectively. Furthermore, a novel compact bed is proposed and its performance is investigated numerically. It consists of repeated packed bed modules. Each module has two layers of packed silica-gel beads separated by vapor passage. Parametric study indicated that the adsorption process is controlled by heat diffusion when heat diffusion time to mass diffusion time ratio (t_{th}/t_m)~O(100) or more. The adsorption process is controlled by mass diffusion when (t_{th}/t_m)~O(1) or less. The calculated specific cooling power of this bed is 3 times higher than that of a plate-fin adsorber. In the near future, an innovative bed will be constructed by growing monolithic nanoporous adsorbent layer on the fins of a heat exchanger. The monolith has vapor channels to reduce vapor diffusion resistance, and its thermal conductivity is expected to be 15 times that of packed silica-gel beds. This new adsorption cooling approach will significantly enhance the performance and extend the applicability of adsorption cooling systems.

Acknowledgements: I would like to express my sincere gratitude to Prof. Louis Chow, Prof. Osama Mesalhy, and my colleague Mohamed Abdelkareem for their technical support, valuable advices, and guidance. Also, I am grateful to the National Science Foundation (NSF) and the Egyptian Ministry of Higher Education for their financial support.

Poster 21-Physico-chemical Characterization of Polk County Landfill Leachate

Jephte Douyon [1], Ecieno Carmona[1], Scott Wallen[1], Aaron Medley[2], Sesha Srinivasan[1]

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Although the traditional disposal of waste in landfills has been practiced for centuries, it still does not qualify as a sustainable process. Many studies have revealed the pollution risk of the leachate (water percolated through the

waste) and its potential for ground water contamination.

Therefore, it is imperative that researchers develop remediation techniques to render the leachate non-hazardous. This project aims to study the physicochemical characteristics (chemical, spectroscopic, elemental, and microscopic) of landfill leachate and to examine the utility of advanced oxidation processes (chemical peroxides/persulfates and photocatalytic) to decontaminate municipal landfill leachate. Leachate remediation was studied to elucidate effects of solution parameters (chemical ratio, dosage, pH level and reaction time). This paper presents the optimal performance delivered by the combination of chemical oxidation/photo-oxidation and its use in decontaminating municipal landfill leachate for safe disposal within regulatory guidelines.

Poster 22-Electrodynamic Mitigation of Dust for the Solar Panels via Computational Simulations

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A largely neglected aspect to prevent energy losses of solar panels is cost-effective mitigation of dust soiling. A potential solution is an electrodynamic dust shield (EDS) to lift and transport dust off panels via electrodynamic waves. The objectives of this research were to determine the effects of EDS design and operating parameters on cleaning efficiency. A discrete element method was used to simulate the transport, and mechanical, adhesive, and electrodynamic interactions of particles. Results showed the optimal distance between electrodes was 14 mm for a standing square wave inclined EDS, which resulted from a balance between increasing pitch that aided dust transport off the panel and concomitant decreasing electric field strength that hindered transport. Optimal voltage was 2.8 kVp-p, while particles remained adhered to the surface at low voltages but at high voltages they remained airborne during the next phase change. Overall, under various conditions, such as horizontal/inclined EDS, traveling/standing wave, low/high particle adhesion, and presence of single/multiple sizes of particles (10- to 200-micron diameter), 10-micron diameter particles were the most difficult to clean, often traveling slightly in the direction opposite to larger particles. Further optimization is required to efficiently clean small particles (less than ~20-micron diameter) along with larger particles.

Our study revealed various ways in which individual dust particles were repelled and attracted by electrodes under different conditions that produced different transport patterns. Results guide improvements of dust mitigation for solar devices to enhance solar energy systems and help ensure clean environments and the advancement of healthy communities.

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Poster 23-Characterization of the laser-based heating system coupled with in-operando Raman spectroscopy

Kangjae Lee, and Jonathan Scheffe

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Two-step redox cycles using a metal oxide have been widely studied for an efficient way of solar thermochemical fuel production. However, using the sun as a concentrated high power heat source has difficulties in repeatability for the lab-scale experiments. Thus, we have developed a 200 W CO_2 laser-based heating system in order to deliver highly concentrated flux to the sample, effectively simulating radiation heat fluxes expected by this sun. This system is coupled with in-operando Raman spectroscopy that provides a means to quantify various properties of materials in-operando at elevated temperatures. Characterization of the laser-based heating system has been demonstrated. Gd-doped and pure ceria pellets were prepared and subjected to rapid heating and cooling at rates higher than 200°C/min. Reduction of Gd-doped and pure ceria under a reducing environment has been tested. Samples were reduced at elevated temperatures with low partial pressures of oxygen achieved by flowing 4 % hydrogen. Raman spectra for both Gd-doped and pure ceria pellets showed high backgrounds below 400 cm-1 and the peak intensity decreased as the samples were reduced. Raman spectroscopy applied to our system is sensitive enough to detect oxidation of the reduced pellets at room temperature or even at elevated temperatures as high as 400 °C depending on the oxidation state of the sample. Gd-doped and pure ceria pellets have been oxidized with either air or CO_2 at various temperatures and Raman spectra were collected during oxidation. In addition, residual gas analysis has been supporting Raman spectroscopy during oxidation.

Keywords: Laser-based heating, Raman spectroscopy, Ceria, Solar thermochemical fuel production.

Poster 24-Solar thermochemical fuel production via redox cycling of metal oxides

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The two-step metal oxide redox cycle, a promising method of solar thermochemical fuel production, is described by an endothermic, solar-driven reaction in which the metal oxide is reduced at high temperatures followed by a lower temperature, exothermic step wherein the metal oxide is re-oxidized with H_2O to produce H_2 or with CO_2 to yield CO. The H_2 and/or CO produced may be used directly to generate power or the mixture of the two, synthesis gas, may be further processed to fungible liquid hydrocarbon fuels via Fischer-Tropsch synthesis. Lab-scale determination of fuel production yields by redox materials is typically performed with excess oxidant, improving the thermodynamic favorability of the oxidation reaction and often leading to unrealistic expectations about material performance.
To assess the viability of redox materials under realistic conditions in terms of their oxygen exchange capacities, thermodynamic properties (enthalpy, entropy, and Gibbs free energy), and reaction kinetics, we have developed a lab-scale tubular reactor capable of operating at temperatures up to 1600°C, total pressures ranging from vacuum to ambient, and oxygen partial pressures (pO_2) from about 10-30 atm to ambient (controlled using a mixture of H_2O and H_2). The system has been validated by performing redox experiments with ceria, the current state-of-the-art, under varying conditions and comparing measured oxygen nonstoichiometries (δ), acquired via residual gas analysis, with

the literature. We aim to employ an improved characterization process to yield more realistic depictions of material performance under industrially relevant conditions. This process involves: (1) measuring δ by performing redox cycles in the presence of H_2O and H_2, (2) quantifying reaction kinetics, (3) calculating thermodynamic properties via the Van't Hoff methodology, and (4) using empirical results and thermodynamic properties to develop an open-system model with which to predict fuel yields and efficiencies.

Keywords: solar, thermochemical, hydrogen, fuel.

Poster 25-Hydrothermal and Solvothermal Synthesis and Characterizations of Oxides

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In this project, we have developed two different synthesis techniques (such as hydrothermal and solvothermal) to obtain oxides and related systems for supercapacitor and water purification applications. The hydrothermal process rely on treating the chemical precursors under a high temperature, high pressure PARR reactor. The various experimental parameters such as temperature, pressure, pH, type of solvents, etc. will be optimized in a Teflon lined SS 316 reactor equipped with rupture disk for safety operation, spinner, thermal probe, gas purge line and water cooling system. On the solvothermal route, the chemical precursors such Titanium Propoxide is treated with different solvents; acids and bases. Similar to hydrothermal route, we have optimized the experimental parameters of this sol-gel process. Thus prepared xerogels have been calcined in a muffle furnace at high temperature for few hours. Structural, chemical, microstructural characteristics have been systematically studied using state-of-the-art tools such as XRD, SEM, FTIR, UV-Vis, and EDS. The physical properties both for supercapacitors and photocatalytic water purification applications have been carried out and will be discussed in this poster presentation.

Poster 26-Designing a batch reactor for UV water filtration

Ecieno Carmona, Sesha Srinivasan

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In this sustainability project, we are looking for ways to maximize the effects of UV-visible light to break down the organic contaminants (azo- dyes) in waste water. A series of homemade batch reactors have been designed and successfully commissioned that have unique 3D printed UV shield enclosures for protecting eyes of the lab personnel. Our reactor enclosure design was based on the precise measurements attained by using Solidworks, a CAD software program, which allowed us to model the parts needed for this project. Another salient aspect of the reactor enclosure design was the installation of a 3D printed tiny and flexible window to view the waste water discoloration status during photocatalytic oxidation treatment. An acrylic lid was custom made with our Laser cutter tool so that it bears the heat due to UV-Vis light source and also enables for the water cooling and air purging plumbing lines. Overall the design and fabrication of the batch reactor was successfully completed in-house, and calibrated for photocatalytic oxidation of organic contaminants in water. (Funding for this project is supported by the Florida Polytechnic University).

Poster 27-How to help companies change their renewable energy focus

Michael Aller, Bennett Boucher, Tim Franta, Henriette Schoen

Energy Florida, Melbourne, FL

Energy Florida is the industry-led nonprofit that connects energy and clean technology industry in Florida and the Southeastern United States with customized services tailored to a company's specific needs.

Energy Florida since its founding in 2010 accomplished many projects in collaboration with NASA, Space Florida, SBDC, FIT, UCF, UCF Venture Lab and Megawatt Ventures, where one of the biggest projects were the Space Coast Clean Energy Jobs Accelerator Project finalized in September 2013, where all together worked on improving the renewable energy focus here in Florida.

Energy Florida has through many different governmental grants, from Economic Development Agency, National Institute of Standards and Technology, US Department of Energy and other entities, worked on efforts proposing new ideas for adaptive change in the energy and cleantech area.

Energy Florida has experience in evaluating and creating value chains in various areas of the energy and clean technology sector, and has directly helped more than 20 companies develop their businesses in various ways leading to improvements that could be measured in by increased revenue.

Energy Florida has created a new division that focuses on consulting and delivering solutions customized to the individual company's needs. The Energy Florida Consulting (EFC) team consists of very experienced individual consultants coming from various professional paths and are subject matter experts in their respective field.

Energy Florida Consulting will in this presentation focus on the area of renewable energy in Florida:

What is the state of the current development

Illustrate where we have companies focused on energy and cleantech

What are the opportunities that lie ahead for the current and future energy landscape both in Florida and all the states in the US

What will the new very recent law (renewable-energy bill SB-90) covering renewable energy tax breaks really means to businesses and individuals in Florida.

Poster 28-Active adaptive fault-tolerant control design for PEM fuel cells

Alireza Abbaspour[*1]*, Kang K. Yen*[1]*, Arman Sargolzaei*[2]

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FL, USA.

2-Electrical and computer Engineering Department, Florida Polytechnic University, Lakeland,

FL, USA.

This paper introduces a novel controller design for pressure control in polymer electrolyte membrane (PEM) fuel cells.

The proposed controller is able to control the system under fault actuator condition. The introduced design uses a neural network for online detection and isolation of faults in the pressure valves of the PEM fuel cell (PEMFC). A nonlinear controller based on feedback linearization controller is used for pressure control, while, a feedback signal from the fault detection system is used to reduce the fault effect on the pressure valves in real time. The simulation results show that feedback linearization controller is vulnerable against fault in the actuators while our proposed active fault tolerant control (FTC) design is able to keep the desirable control performance in presence of faults in the PEMFC actuators.

Keywords: Nonlinear control, online fault detection, air supply, extended Kalman filter, sustainable energy source.

Poster 29-Poly Primer Course Development on Renewable Energy Systems and Sustainability

Austin Wise, Daniele Salvador, Constantine Stefanakos, Scott Johnson, Jaspreet Dhau, Ryan Integlia, Sesha Srinivasan

Florida Polytechnic University, 4700 Research Way, Lakeland, FL 33810.

Primer on "Renewable Energy Systems and Sustainability" is based on our successful implementation and outcome of EEL 3287 course which was executed in Fall 2016 semester. This primer is effectively integrated into the canvas learning management system in form of course modules having pre-lecture videos and animations. Each module of videos is pertinent to a particular concept, for example, solar energy. The videos are divided into 10-20 minute long videos packaged into the module for easy access. Storage wise, the videos take up a lot of space. So to be storage efficient the videos were uploaded to Youtube and organized and further embedded into canvas from there. Some of the software and hardware used for this primer development is given here (Apple Mac, Adobe Premiere Pro, Youtube). Other support services in campus such as Cyber Gaming and Media Lab (CGM Lab), and Canvas LMS administrative permission etc. were used to help realize the course. This Primer will be the precursor for those taking EEL 3287 or similar Green Technology courses. Quizzes and solutions will be developed which will reflect the current trends and scenarios. The primer's usefulness to the large audience and course assessment plans will be developed while primer starts collecting the data.

Poster 30-Ink-jet nanoprinting Graphene/Perovskite combined solar cells

Yassir Bello, Inna Kravchunovska, Eric Rippe, Enrique Hernandez, Marianne Feoli, Scott L. Wallen, Scott Rheinhart Nicoleta Hickman

Florida Polytechnic University, Lakeland, FL 33805

Perovskites are new emergent materials with promising applications in the photovoltaic field. Perovskite solar cells are flexible, inexpensive to produce, and simple to fabricate. Scientists have reported three general deposition methods to prepare a perovskite solar cell: spray coating, spin coating or vacuum deposition. The main problem with these new solar cell devices is the decrease of efficiency after a short period of time due to the weather changes and extreme light flux.

This work presents an ink-jet nanoprinting process that makes the manufacturing of organic-inorganic perovskite solar cells a viable, low-cost alternative to expensive, conventional solar cells.

Solutions of synthesized $CH_3NH_3PbI_3$ and $CH_3NH_3PbI_3$-xCl_x inks are directly printed on indium tin oxide (ITO)/

graphene coated glass substrate. The graphene has been introduced into the material and its effect on improving the degradation rate and increasing the overall efficiency is examined. Various techniques and methods were used to evaluate the performance of the material with the fabrication method used. Additionally, full characterization and analysis of the structure and composition of the system were performed.

Poster 31-Kinetics of Methane-Driven Ceria Reduction

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Department of Mechanical and Aerospace Engineering, University of Florida, Gainesville, USA, 32611

Solar chemical-looping reforming over ceria redox intermediates is a promising pathway towards the sustainable production of synthesis gas. The aforementioned cycle consists of: (1) endothermic reduction of ceria and simultaneous partial oxidation of methane and (2) exothermic oxidation of the reduced ceria via H_2O and/or CO_2 splitting. Here, using thermogravimetric analysis (Mettler Toledo TGA/DSC 2), we examine methane-driven ceria reduction (reaction 1) through isothermal and nonisothermal mass relaxation experiments to elucidate kinetic parameters. This reaction was studied under for a wide range of temperatures ($1023\ K \leq T_{iso} \leq 1373\ K$, $673\ K \leq T_{non\text{-}iso} \leq 1373\ K$), powdered masses ($5\ mg \leq m CeO2 \leq 25\ mg$), and methane concentrations ($0.005 \leq p CH4 \leq 0.03$). Observed linearity in the natural logarithm of experimental rate data versus inverse temperature confirms Arrhenius-type dependency, and effective activation energies are published as a function of ceria nonstoichiometry for both isothermal and nonisothermal methodologies.

Keywords: solar, methane, reforming, ceria.

Poster 32-Nano-printed Flexible Graphene Coated Aluminum Electrodes for Highly Efficient Supercapacitors

Nicoleta Sorloaica-Hickman, Eric Rippe, Inna Kravchunovska, Yassir Bello, Enrique Hernandez

Florida Polytechnic University, Lakeland, FL 33805

Although Graphene has been considered as a very promising material for power generation, thermal management and energy storage applications, the poor control of the distribution of Graphene and the limited way of fabrication process hinder its power performance.

We report a fabrication process for the electrochemical supercapacitor using a 3D Nano-printing technique. The method relies on creating a flexible frame for the energy storage device by depositing the Graphene nanoflake inks on aluminum electrodes. The 3D supercapacitor has been made and evaluated in this study.

Poster 33-Ultra-high Efficiency DC-DC Converter with Nanocrystalline Inductor for Battery-Integrated PV Applications

Xi Chen, Anirudh Pise, John Elmes, Issa Batarseh

University of Central Florida, Orlando, FL

In battery-integrated photovoltaics (PV) applications, a DC-DC buck/boost converter is commonly used to regulate

the output voltage from a variable voltage source to maximize solar energy harvesting. The cascaded buck-boost (CBB) converter can achieve highest efficiency due to its low voltage and current stresses when compared to other converters. However, because of many limitations, the selected components may not be optimized. Due to the requirement of operation under high temperature and high AC current ripple, it is critical that the inductor in any proposed CBB should have very low core and copper loss. The commercially available inductors cannot meet these specific requirements. Therefore, it is proposed that nanocrystalline material shall be used to make the inductor core. This kind of material has characteristics of high magnetic field saturation level (1.18T) and high permeability (14,000H/*m* at 100 kHz), which help reduce the number of conductor turns for a certain inductance. The designed core is a E-shaped core, which is a more symmetric solution to form a closed magnetic system. The electric circuit is wound around the center leg, whose section area is twice that of each individual outer leg. The designed core also exhibits low magnetostriction due to the core material (Metglas FT-3W), which corresponds to low AC losses. Furthermore, because air gap is necessary in the core to achieve the certain inductance, this very thin core material (17μm) can significantly reduce the air gap loss from eddy-current. Typically, the air gaps are distributed in the center leg and outer legs in order to achieve stability. Copper foil conductors are used to perform as inductor winding. For the specific application we have been working on, this designed inductor has 5 turns, total giving 2.6mΩ. Moreover, this inductor design gives very low skin effect loss and proximity effect loss. It will be shown that with the nanocrystalline inductor, the converter's maximum efficiency is improved from 98.02% to 98.91% at full load (120W), which is 1.07W improvement.

Poster 34-Printable Thermoelectric Elements for Energy Harvesting and Heating/Cooling Applications

Enrique Hernandez, Yassir Bello, Eric Rippe, Inna Kravchunovska, Scott Reinhart, Nicoleta Hickman

Florida Polytechnic University, Lakeland, FL 33805

We report the fabrication and testing of Bismuth Telluride (Bi_2Te_3) based thermoelectric (TE) materials using a 3D nanoprinting technology. In this study, printable thermoelectric inks and thin films were fabricated and characterized. This work aims to demonstrate that the low-cost ink fabrication, printing technology, and low-temperature TE materials are promising for the fabrication of efficient flexible thermoelectric modules for energy generation and cooling/heating applications. With this work, in addition to the commercial value of flexible thermoelectrics, we could also be advancing the state of the art in both electronic device printing and thermoelectric device design by applying high volume roll-to-roll printing techniques to thermoelectric devices, building on the recent advancements in printing electronic devices and circuits.

Poster 35-Cool Particulate Regeneration

Matthew Lawyer[1], Brett Bailey[2], Sesha Srinivasan[1]

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Cool Particulate Regeneration – (CPR) is an innovative technology that uses reverse flow created by rapid digital sequence of exhaust valves and exhaust flow crated by the engine to clean the diesel particulate filter thus eliminating the need to thermally clean it. It does this by sealing the exhaust behind the filter and then opening a

volume before the filter which creates a back flow. This back flow separates the particulate from the filter and caries it into the opened volume which leads to a settling tank. If done properly CPR would completely remove the need for active regeneration thus allowing a diesel engine to be cheap, efficient, and environmentally friendly. However, the back flow is turbulent and has in the past not cleaned all areas of the filter. This poster presentation features an initial findings of a computational fluid dynamics simulation used to find a solution to the turbulent flow issue, the applications of the technology, and the current stage of development.

Poster 36-Concept for Environmental Monitoring UAV Hive Mind Framework

Luke J. Nichols, Zachary Weingarten, Moshe Acevedo, Eric Williams, Ryan Integlia

Florida Polytechnic University, 4700 Research Way Lakeland, FL 33805

The development of a UAV hive framework on microcomputer based mesh networked UAV platform for environmental monitoring and the cultivation educational project engagement. The UAVs use a mesh network to communicate, provide context information through various sensors and imagers to coordinate operations through central decision making process. The UAV hive minds goal is to collect data and distribute it on a mesh to make actionable intelligent decisions with applications of environmental monitoring and potentially related operations.

Poster 37-Fuzzy Based Control Approach for Three-Phase Single-Stage Grid-Connected Photovoltaic Module-Integrated Converter

Arman Sargolzaei[1], Alireza Abbaspour[2], Ben Amaba[2], Jeff Daniel[2], Saman Sargolzaei[2]

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Over the past decades, the trend toward sustainable energy is growing, rapidly. However, to integrate them to the grid, inverters are used. The inverters should convert the direct current (DC) to alternating current (AC) with minimum harmonics. One of the main advantages of renewable energies is their flexibility to control and compensate the generated power in case of emergencies and faults. This can be done by connection of multi inverters to the grid which their power can be controlled through a centralized cloud based control system. This type of design has recently got a significant amount of attention due to its benefits such as high efficiency, low mass production cost, improved energy harvest, and easier installation. So, they should be designed very compatible with the grid line. Due to technical challenges of how to control the power and voltage in a stand-alone and Grid-connected inverter, their robust control design has been focused by researchers.

In this paper, a new control method based on fuzzy logic is implemented to control the active and reactive power of a three-phase current source boost inverter to boost the efficiency. The proposed procedure utilizes the SVPWM switching pattern with advantages of simple implementation and decent DC-bus utilization. Moreover, it's capable of boosting the low DC voltage to a higher amount in just one stage.

In previous studies, the control topologies and methods for grid-connected single stage boost inverters was not to response to fast step power changes. Furthermore, the capability of independent control for active and reactive power was ignored or the controls topology could just follow the injected active power and the reactive power should be set

to zero. The simulation analysis of the proposed control technique is conducted using MATLAB which shows that our method is able to track the active and reactive power accurately.

Poster 38-A Fuzzy Logic-Based Gain Tuner for Energy-Efficient Control of Brushless DC Motors

Michael Midence, Arman Sargolzaei

[1]Florida Polytechnic University, Lakeland, FL, USA

Brushless DC Motors (BLDCM) are fast outstripping their commutator-driven predecessors as the future of electric motors. Their implementation in electric vehicles and unmanned aircraft has shown such promise that BLDCM are even working their way into industrial settings. To this end, the goal is always to find more cost/energy-effective strategies to drive and control these motors. Improving BLDCM's response characteristics such as speed and torque control also has its place in academic pursuit and has been traditionally undertaken using PID controllers. By following the process outlined in the other papers, this paper provides an insightful approach to acquire a Fuzzy Logic Tuner (FLT) to make the PID controller more robust using a feedback loop to adjust the gain constants K_p , K_I, and K_D thereby lessening the torque stress and current draw under varying conditions of load application. By modeling in Simulink, we will show that the FLT applied PID controller will reduce M_p (percent overshoot) and t_s (settling time), which has direct effect in its energy usage. As this system is a modification of a stable system, we will be less concerned with system stability and more focused with using dynamic modeling to improve response characteristics.

Poster 39-Back to Nature Intelligent Gardening

Muneer Tatum, Eric Rippe, Inna Kravchunovska, Yassir Bello, Enrique Hernandez, Scott Reinhart, Ryan Integlia, Nicoleta Sorloaica-Hickman

Florida Polytechnic University, Lakeland, FL 33805

Introducing advanced technology elements into the field of agriculture can effectively overcome the negative impacts of climate change, geographical limitation and natural disasters. These technologies include monitoring, recording, and tracking of the whole crop-growing process from the initial production to processing, transportation, sales and other procedures and activities.

We designed and identified a set of sensors, sensor integration, automatic controls, information processing, and network communications capabilities, all coupled with a "cloud" architecture. The control and monitoring systems were designed to provide remote monitoring and automation management of both traditional and hydroponic gardens. The system can deploy and control the most important elements for healthy vegetables including the water quality, nutrient solution and irrigation schedule.

Poster 40-Structural and Photolumiization Characterization of Ba2SrGaO4F

Valinteshley Pierre and Robert Green

Florida Polytechnic University, Lakeland, FL

Ba_2SrGaO_4F, a novel material in the Sr_3AlO_4F family of tetragonal oxyfluoride materials, has been synthesized via

solid-state method. Much like its non-barium containing predecessor, self-activated photoluminescence (PL) under 254nm light is observed after annealing in a reducing atmosphere of 5%H_2/95%Ar. The structure of this material is studied using high-resolution powder x-ray diffraction, which reveals similarities to Sr_3AlO_4F and Ba_2GaLaO_5. At room temperature this anti-perovskite structure reveals changes in the polyhedral sub-units between the reductively annealed and air-annealed samples, which shows no PL. The PL intensity as well as the excitation wavelength of the reductively annealed material allows for potential use as a solid-state lighting phosphor.

Poster 41-Accumulation of Error through to Propagation in Smart Grid Energy Efficiency Measurements

Aleksandar Damjanovic, Ryan Integlia

Florida Polytechnic University, Lakeland, FL 33805

The efficiency of the distribution of energy in smart grid is in the range of (85-99)%, which means that up to 15% of the energy is wasted in the losses of power transmission devices such as power transmission and distribution lines and power transformers. The efficiency is defined as the ratio of the output and the input powers. Input power is the sum of the output power and associated losses. Smart Grids typically supply a very high percentage of non-linear loads. These loads increase losses in the transmission and distribution system, and in devices, such as power transformers, motors, and generators.

Measurement of the losses under nonlinear load conditions can be done only when the load is connected, i.e., in real working conditions. The connection of the instrumentation is on the input and the output terminals of the measured system. The measured system is considered as a two-port network in which the losses are dissipated. The importance of estimating of errors in measurements is because data errors propagate through to calculations and produce errors in the final, measured results. Error propagation through calculations depends on the nature of the calculations. The errors penetrate through calculations and algorithms of measurements. Although the distribution of errors in the instrumentations, includes CTs, VTs, and, A/D conversion, V and A-meters, etc. are of stochastic nature, the penetration of error through to calculations is of deterministic nature. When the measured results are obtained by complex calculations and algorithms, the total errors, accumulated, can be calculated only by the algebra of the propagation of errors. Neglecting propagation of errors through to calculations can lead to an erroneous conclusion about the results of measurements.

Poster 42-Assessing socio-economic and socio-psychological determinants of energy-conservation attitudes among homeowners in Florida

Prami Sengupta, Randall Cantrell, Victor Harris and Tracy Johns

University of Florida, Gainesville, FL

Energy consumption is one of the major contributors to global warming, environmental degradation, and human rights violations. The United States has consistently ranked the highest in global residential energy consumption and the country's demand for residential energy is predicted to grow. Household energy use contributes to nearly one-fourth of the country's total energy consumption. Although the scope of reducing energy consumption at a

household level is immense, the answer to what influences people to consume and conserve energy remains far from being conclusive. The patterns of attitudes, social structural constraints, beliefs, and behavior vary significantly among households. Therefore, one of the fundamental consumer objectives required for the reduction in residential energy use is the development of positive energy-related attitudes among residents.

The goal of this study is to examine the socio-economic and socio-psychological determinants of homeowners' energy-conservation attitudes by using the Theory of Planned Behavior. First, the study explores the various possible determinants of individuals' energy-related attitudes based on existing literature. Second, it examines the relationships between demographic, socio-economic, and socio-psychological characteristics of homeowners' and their energy-conservation attitudes using multivariate regression analysis. Third, the study analyzes the levels of variability of homeowners' energy-conservation attitudes within various demographic groups using ANOVA. Data were collected from 1467 homeowners between the ages of 25 and 75, residing in one of the 67 counties of Florida. By exploring an array of possible determinants of homeowners' energy-conservation attitude, this study simultaneously contributes to both socio-psychological and energy policy literature of residential energy consumption. Moreover, the current political polarization regarding energy use and climate change further asserts the importance of the study.

Poster 43-Novel nanocomposite polymer-dye touchchromic device

Sharan Kumar Indrakar[1], Elias Stefanakos[1,2] and Manoj Kumar Ram[2]

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Recently, we reported a novel and cost effective thin film based nanocomposite layer that enables reversible color change from dark to transparent when the film is touched by a specific metal without any external energy, that is, voltage, light or temperature [1, 2]. The structure of the touchchromic device is the nanocomposite layer on a conducting surface; a solid, liquid or gel electrolyte on a translucent conductive substrate, as fluorine doped tin oxide (FTO), and a metal are required for the color change. The coloration and discoloration of the nanocomposite depend upon various aspects like composition of the electrolyte, film thickness and nature of the composite film.

In this work, we will present color change results of a conducting polymer composite-dye thin film on a FTO substrate using an electrochemical method. The composite film was characterized using UV-vis, FTIR, SEM, X-ray diffraction techniques. The coloration and decoloration of the composite film was studied with the use of iron and nickel metals. The coloration and decoloration depends on the properties of the metal and type of electrolyte. The touchchromic device can find applications in windows and displays.

[1] Manoj Kumar Ram, D. Y. Goswami and E.K. Stefanakos, Metal Sensitized Color Changing Material, US Patent number, 20160109776 (2016)

[2] Manoj K. Ram, Arash Takshi, D. Y. Goswami and Elias K. Stefanakos, Low-Cost Chromatic Devices, US patent number -A14/425,568. (2013).

Poster 44-Smart Agriculture Software for Sustainability

Rick Montney[1], Ryan Integlia[2]

ProPak Software[1], Winter Haven FL, 33880

Florida Polytechnic University[2], Lakeland, FL 33805

Agriculture software development promoting efficient and effective use of our natural resources enables sustainability towards enhanced food security. The LandMagic software case provides the foundation for agriculture farming operations to monitor land, water, and energy, sustainability efforts with the potential to integrate additional technology to support demands food safety, transparency, and healthy food products. Emerging and affordable technologies such as high resolution imagery from drones, planes, and satellites, coupled with analytic algorithms, delivered in a simple to use map dashboard, presents new opportunities to the agriculture industry and the challenge to meet the 2050 food demand. Collectively, the awareness of these trends, demands and technology resources enables climate aware agriculture, as part of a global challenge centered on water, food and environmental security that impact the longevity of our society.

Poster 45-Sustainable Agriculture Labor Management

Tyler Hyatt[1], Ryan Integlia[2]

Time Portal[1], Florida Polytechnic University[2]

Accurately tracking agriculture labor and harvesting activities from the field to the fork is a challenging endeavor for the average farming operation and labor service providers. A wide variety of data collection systems and devices are available today to track workers, time, piece counts, breaks, job tasks, and work crews, for domestic, H2A, and migrant workers, along with the corresponding efficient coordination of resources, workers and scheduling towards a sustainable outcome. Barcoded badges, RFID, biometrics, imaging, various sensors, GPS and signatures, represent worker verification methods at various price points, but also enables functionality to support future growth of the technology for crop yields, quality, safety, and maintenance and impact awareness. Time Portal Software brings a new level of agriculture labor management, while establishing a platform for ongoing development for the betterment of the industry, with the understanding that sustainable farming requires a reliable workforce.

Poster 46-Sustainability Committee at Florida Polytechnic University: Formation, Development and Future Work

Hayden Salmon, Justin Florian, Daniel Salvador, Mark Glaser, Sesha Srinivasan, Nicoleta Sorloaica-Hickman, Ryan Integlia

Florida Polytechnic University, Lakeland, FL 33805

The Sustainability Committee was founded with the purpose of establishing a culture of ethical stewardship for the longevity of our environment, community, infrastructure and society at Florida Polytechnic University. The development of the sustainability committee is empowered by the passion, creativity and innovative spirit of our university community. The generational perspective on sustainability requires continual engagement with students, industry, the local community, along with the national and international forums and organizations that serve sustainability issues. The academic engagement began with participation in courses to support awareness

and grew to participation. Projects emerged supporting ongoing efforts involving Florida Industrial Phosphate Research institute, smart electric solar vehicles, smart farming & community gardens, sustainability of worker welfare, upcycling smart phones/computers for educational technology, sensor networks for environmental monitoring & other. Additionally, the ongoing activities and events to bring awareness of the need for sustainability, such as the blackout, Earth Day, Arbor Day, conferences, workshops, competitions, and the sustainability competition. Industry engagement for the student community involved supporting guest lectures, technology demonstrations and internships. Future work includes participating in more national competitions, community service for poverty elevation or potential projects like smart net zero cities and UAV based environmental monitoring, and participation in international forums.

Poster 47-Global Warming Costs and a justification for Renewable Energy

Rishabh Lala[1] Fazil T. Najafi[2]

Department of Civil and Coastal Engineering, University of Florida, Gainesville, FL

The objective of this research is to present the costs of global warming worldwide. The cost is presented in comparison to the environmentally sustainable solutions including use of renewable energy. Renewable energy such as solar, wind and geothermal are in natural abundance, while fossil fuels have a life span limited to this half of the present century. Furthermore, fossils energy fuels global warming by producing carbon forms which hinders the protective ozone formation. Global warming results in global temperature, sea level and biotic health hazard rise resulting in annual economic losses. For a period of 50 years the economic loss is estimated to the United States taking into account effect of rising sea levels including potential for saltwater intrusion on drinking water supplies, growing damage caused by increased storm surge and loss of physical property due to potential floods. The losses are further compared to the benefits of economic benefits of green energy. Total losses are the factored algebraic sum of the two. It is predicted the world is headed toward catastrophic 6 degree Celsius global temperature increase. Responsive methods will cost about 1 percent global GDP per year amounting to $44 trillion internationally by 2050. However, cutting fossils fuels usage saves money, while simultaneously producing jobs in millions worldwide. OECD nations have inadequate plans to counter global warming. Pollution due to downwind direction cross state lines and burden innocent states causing human health hazards directly or indirectly is accounted in the study as economic loss. The study mathematically evaluates the economic scope of green energy region wise throughout the United States through a state-of-the-art literature review.

Poster 48: Fabrication of Graphene nanoflake highly conductive inks

Nicoleta Sorloica-Hickman, Inna Kravchunovska, Eric Rippe, Yassir Bello, Enrique Hernandez, Scott Reinhart

Florida Polytechnic University, Lakeland, FL 33805

Deposition technology of transparent and highly conductive Graphene thin films is very important for high performance solar cells. Here we report a binder-free preparation technique of graphene conductive inks by dispersing and drastically reducing the size of the pristine graphene sheets directly in Ethylene glycol. Based on our investigation this technique offers a good approach to ink development with tunable ink characteristics and properties such as Graphene nanoflakes concentration, viscosity, surface tension, electrical and thermal conductivity and solvent evaporation to meet the requirements of the printing technology. Solution-based fabrication method implemented in our laboratory can result in substantial cost reduction of the large-scale manufacturing processes.

ADDITIONAL INFORMATION

applied sciences

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Special Issue

Clean Energy and Fuel (Hydrogen) Storage

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Deadline for manuscript submissions:
31 December 2017

Message from the Guest Editors

Clean energy and fuel storage is often required for both stationary and automotive applications. Some of these clean energy and fuel storage technologies are hydrogen storage, direct electric storage, mechanical energy storage, solar-thermal energy storage, electrochemical (batteries), and thermochemical storage. The gravimetric and volumetric storage capacity, energy storage density, power output, operating temperature and pressure, cycle life, recyclability and cost of clean energy or fuel storage are some of the factors that govern efficient energy and fuel storage technologies for potential deployment in energy harvesting (solar and wind farms) stations and on-board vehicular transportation. This Special Issue serves the need to promote exploratory research and development on clean energy and fuel storage technologies while addressing their challenges to a practical and sustainable infrastructure. We invite contributions in topics that include but not limited to various state-of-the-art energy and alternative fuel storage technologies.

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iCascade is a journal created by faculty and students at Florida Polytechnic University. It is published twice a year, and features STEM research and topics. The title is an acronym for specific areas of focus: Innovation, Communication, Applied Sciences, Computation, Analytics, Design, and Engineering.

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Bringing Energy Solutions to Serve Florida, the Nation, and the World

*The **Florida Energy Systems Consortium (FESC)** was created by Florida Statute to unite Florida's universities to position the State of Florida as a leader in energy research, education, innovative technologies, and energy systems analysis. The consortium accomplishes this goal through sharing energy-related expertise and promoting collaboration among energy experts at its 12 public universities and with Florida industry.*

The Consortium supports the Florida Department of Agriculture and Consumer Services' Office of Energy (FDACS OOE) in advancing alternative energy strategies, improving energy efficiencies and expanding economic development for the State of Florida.

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- Energy education at community colleges leading to A.S. Degree and College Credit Certificates (CCC) in collaboration with Florida Advanced Technological Education Center (FLATE):
  - *Engineering Technology A.S. Degree with specializations in Alternative Energy Technology and Industrial Energy Efficiency*
  - *CCC in Alternative Energy Systems Specialist and Industrial Energy Efficiency Specialist*
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  - *Research on sustainability staffing and practices at state and community colleges*
- Nuclear energy education via the nuclear training reactor at the University of Florida
- Undergraduate and Masters level energy course offerings and on-line certificate programs at FESC universities

OUTREACH

- Leveraging the existing network of extension offices within Florida to deliver educational programs and fact sheets related to energy and resource-efficient community development
- Annual workshops, FESC e-newsletters, and web-site: *www.FloridaEnergy.ufl.edu*

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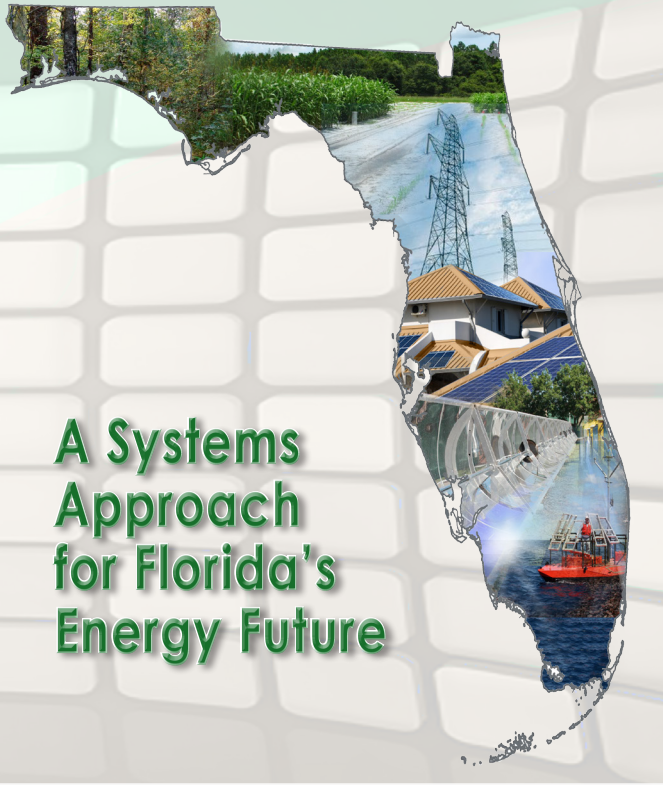
FESC
Florida Energy Systems Consortium



A Systems Approach for Florida's Energy Future

Leadership In Energy Research Enabled by a Systems Approach

"Florida Universities innovating for a sustainable energy future"

FOCUS AREAS TOWARDS FLORIDA'S ENERGY LEADERSHIP

The Florida Energy Systems Consortium's (FESC) research program has five focus areas. In each of these areas, Florida's state universities partner with industry to provide technical expertise to meet pressing industry needs and to bring emerging energy technologies to market.

The novel technologies developed by FESC harness Florida's natural resources and reduce energy dependency on outside sources. In addition, these focus areas are represented in the Consortium's workforce development programs, which serve Florida's industries and utilities, and in the Consortium's outreach programs which serve the public by reducing their energy bills through conservation.

CONVERTING FLORIDA'S BIOMASS TO RENEWABLE FUELS

Florida ranks first in the country in annual generation of cellulosic biomass with almost 10% of the US total. In Florida, several biomass species are produced in large volumes, primarily sugar cane bagasse in South Florida, citrus peel in Central Florida, and woody biomass in North Florida. Florida's location and resources position it to be a leader in the development and commercialization of biomass-to-fuel technologies in partnership with the private sector. Such leadership brings investment, jobs, and tax revenue to the State and diversifies Florida's economy, while making it more sustainable. The key research focus areas include:

- Feedstock Development and Deployment
- Cellulosic Biomass Technologies
- Algae Technologies
- Anaerobic Digestion Technologies

SUPPORTING UTILITIES IN SMART GRID AND ENERGY STORAGE

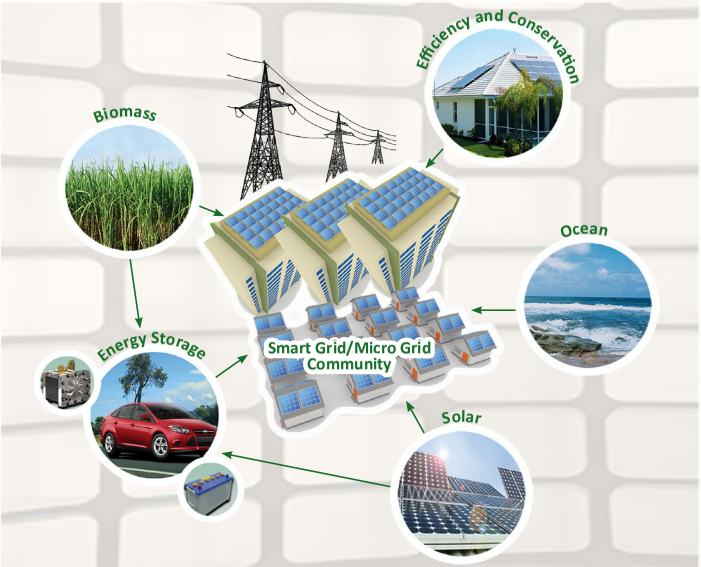
FESC supports Investor Owned Utilities (IOU), Cooperative Electric Utilities, and Municipal Utilities to develop smart grids with intermittent power sources such as PV and wind, distributed electric generation, state-of-the-art power electronics, and grid level energy storage. The areas of collaborative research include:

- Florida's generation capacity growth, transmission grid expansion, efficiency, and grid modernization
- Florida's distribution grids, distributed generation resources, demand side management, and on-premise appliance integration in efficiency programs
- Integration of renewables to the grid
- Resilient grids via advanced cyber-physical systems
- Floridian economics and consumer behavior

OVERARCHING UNDERSTANDING OF FLORIDA'S ENERGY SYSTEMS

Overarching to the Consortium's research strategy is an energy systems approach to develop integrated systems with robust designs and holistic practice. The goals are:

- Identify and evaluate research opportunities
- Perform selected and recurring analyses
- Provide objective and quantitative assessments to the state
- Evaluate alternative power delivery and transportation systems



ENHANCING ENERGY EFFICIENCY AND CONSERVATION

Energy efficiency and conservation offer the greatest potential to reduce Florida's energy consumption. Buildings use more energy than any other sector of the economy, including transporation and industry. Because of Florida's hot and humid climate, much of the building sciences research conducted nationally doesn't apply well in Florida. Building performance research is needed to evaluate and support implementation of specific efficiency practices in Florida. Research focus areas include:

- Energy efficient building technologies such as high efficiency HVAC for residential and commercial buildings
- Analysis of metered energy consumption data to increase effectiveness of Florida utilities' Demand Side Management (DSM) programs

POWER GENERATION: MARINE HYDROKINETIC RESOURCES

Covering more than 70% of the Earth's surface, the oceans collect and store the sun's vast energy quite effectively, which is available 24/7 in various forms (tides, waves, ocean currents, gradients, etc.). Surrounded by the ocean on three sides, and with the second longest coastline of all U.S. states, Florida is uniquely positioned to harness marine renewable energy resources. Research focus areas include:

- Ocean Current Energy
- Ocean Wave Energy
- Ocean Thermal Energy
- Offshore Wind

HARNESSING FLORIDA'S SOLAR ENERGY

Florida has substantial solar energy resources and a strong incentive to enable power production for the grid, thermal desalination, clean fuel production, and solar cooling. FESC leads a rigorous and transformational solar energy research effort to develop the next generation solar energy technologies. The research focus areas include:

- Thin film and organic solar cell development and their systems integration
- Concentrated Solar Power (CSP) and high-temperature thermal energy storage development
- Solar fuel development for transportation - convert water and carbon dioxide to syngas then liquid fuels by using solar energy
- Heating, cooling and clean water by using solar energy
- Automatic permitting, automatic utility interconnection and autonomous operation of PV systems

SUSTAINABILITY COMMITTEE OF FLORIDA POLYTECHNIC UNIVERSITY

The sustainability committee was founded Fall of 2015 under the Student Government Association to create and encourage an action oriented stance towards increasing the environmental efficiency and responsibility of the University. There was a need to promote a cleaner way of living as well as integrating more renewable technology on our campus. This group helps support various projects and events that demonstrate how this cutting edge technology can be used today. Projects that the committee has been a part of include the smart electric solar vehicles, smart farming & community gardens, upcycling smartphones/computers for educational technology, and creating sensor networks to increase the collection and distribution of information.

Every great invention simply starts with an idea. This committee is committed to helping students realize their potential by supporting those ideas through offering the opportunity to work side by side with our outstanding professors and staff on an existing project or start one of your own. Learn all the steps on how to write a professional proposal. In the photo above it there is a test bed for what our Smart Electric Solar Vehicle will be based on. Building a vehicle designed by students, hundreds of experiments will be run at the future SunTrax Facility in a few years using various technologies such as Arduinos and Raspberry Pi. Using these tools to measure countless statistics to help progress sustainable sciences.

Promoting Community outreach is a pillar to our mission. We propose to be out and helping serve the community and truly spread the idea of a more healthy and sustainable Earth.

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Abbaspour	59, 63
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Abdelkareem	51, 55
Acevedo	63
Ackerman	40
Aller	9, 29, 59
Almatrafi	50
Alsenas	8, 16-17
Alshdoukhi	45
Altpeter	11, 21
Amaba	63
Askanani	56
Bailey	11, 22, 63, 75
Bandyophadyay	8, 17-18
Barooah	46, 48
Batarse	62
Belicka	9, 19
Bello	30, 34, 60-62, 64
Bhethanabotla	43
Bittencourt	47
Boucher	59
Bowman	26
Brooker	9, 27
Brooks	48
Bruderly	10, 39
Burk	4, 13, 15
Cantrell	66
Carmona	7, 55, 58
Carrasco-Pena	49
Carrillo	57
Chabi	54
Chasar	32, 35
Chen	62
Chesnutt	56
Coffman	46
Collins	28
Colon	44
Coughlin	49
Curley	33
Damjanovic	65
Daniel	63
Daou	45
Daza	43
Dhau	7, 12-13, 31, 40, 42, 60
Dixon	47
Douyon	7, 55
Eggers	9, 20
Elmes	62
Ergas	47
Faruque	28
Feiock	10, 33
Feoli	60
Florian	68, 74
Francis	28
Franta	10, 32, 59
Freund	45, 54
Garcia	10, 33
George	20
Glaser	68
Goswami	12, 29, 44, 50, 67
Grasso	49
Guo	56
Gupta	28
Hale	30
Hare	43
Harper	28
Harris	66
Hernandez E	30, 34, 61-62, 64
Hernandez T	8, 16
Hickman	10, 12, 30, 34, 60-62, 64, 68
Horton	11, 22, 49
Hyatt	67
Indrakar	66
Integlia	7, 12, 40, 60, 63, 65, 67-68
Jimenez	47
Johns	66
Johnson M	23, 51
Johnson S	60
Jung	21
Kannan	21
Karan	21
Keys	36
Kibert	39
Kim	46, 54
Kravchunovska	30, 34, 60-62, 64
Kuhn	9, 19, 43
Lala	68
Landis	40
Lawyer	7, 63
Lee E	47
Lee K	57
Madhosingh-Hector	12, 40
Maiti	43
Martin	10, 23, 32, 35
Mbah	45
Mcllvaine	35
Meeker	9, 12, 28, 30
Mehmet Oz	21
Merotto	21
Mickel	12, 34
Midence	64
Mills	30
Moloney	50
Montney	67
Najafi	68
Nakamura	56
Newaz	28
Nichols	63
Nilsen	4, 8, 15
Niroumand H	10, 39
Niroumand N	39
Norton	3-4, 7-8, 14
O'Brien	7, 58
Ohagwa	45
Ordonez	10, 12, 35, 37

Orlovskaya 49
Ospina 28
Parker D 32, 44
Parker T 4
Pierre 65
Pise 62
Pootoon 45
Qu 9, 10, 28, 37
Radovic 49
Ram 66
Raman 48
Ramona 12
Rashid 10, 12, 31, 37-38
Reece 49
Reedy 34
Reinhart 30, 62, 64
Rippe 30, 34, 60-62, 64
Rishabh 68
Rittenhouse 41
Rockwood 11, 26
Salmon 68, 74
Salvador 60, 68, 74
Sargolzaei A 59, 64
Sargolzaei S 63
Scheffe 57, 61
Schoen 59
Seepaul 20
Sengupta 66
Small 9, 20
Srinivasan 7-8, 12-13, 40, 42, 55, 58, 63,68
Stefanakos C 60
Stefanakos E 44, 66-67
Tatum 64
Underwood 49
Uribe-Romo 49
Vasquez-Molina 49
Vermerris 9, 20
Vital 49
Wallen 7, 13, 41, 55, 58, 60
Wang 47
Warren 61
Wassel 33
Watano 56
Weil 23, 51
Weingarten 63
Wemple 41, 58
Williams 63
Wilson 30
Wise 7, 58, 60
Withers Jr 12, 32, 35
Wright 20
Wu 56
Yen 59
Zeng 48
Zeyghami 44
Zhang 46-47, 55
Zin 27
Zubaly 30

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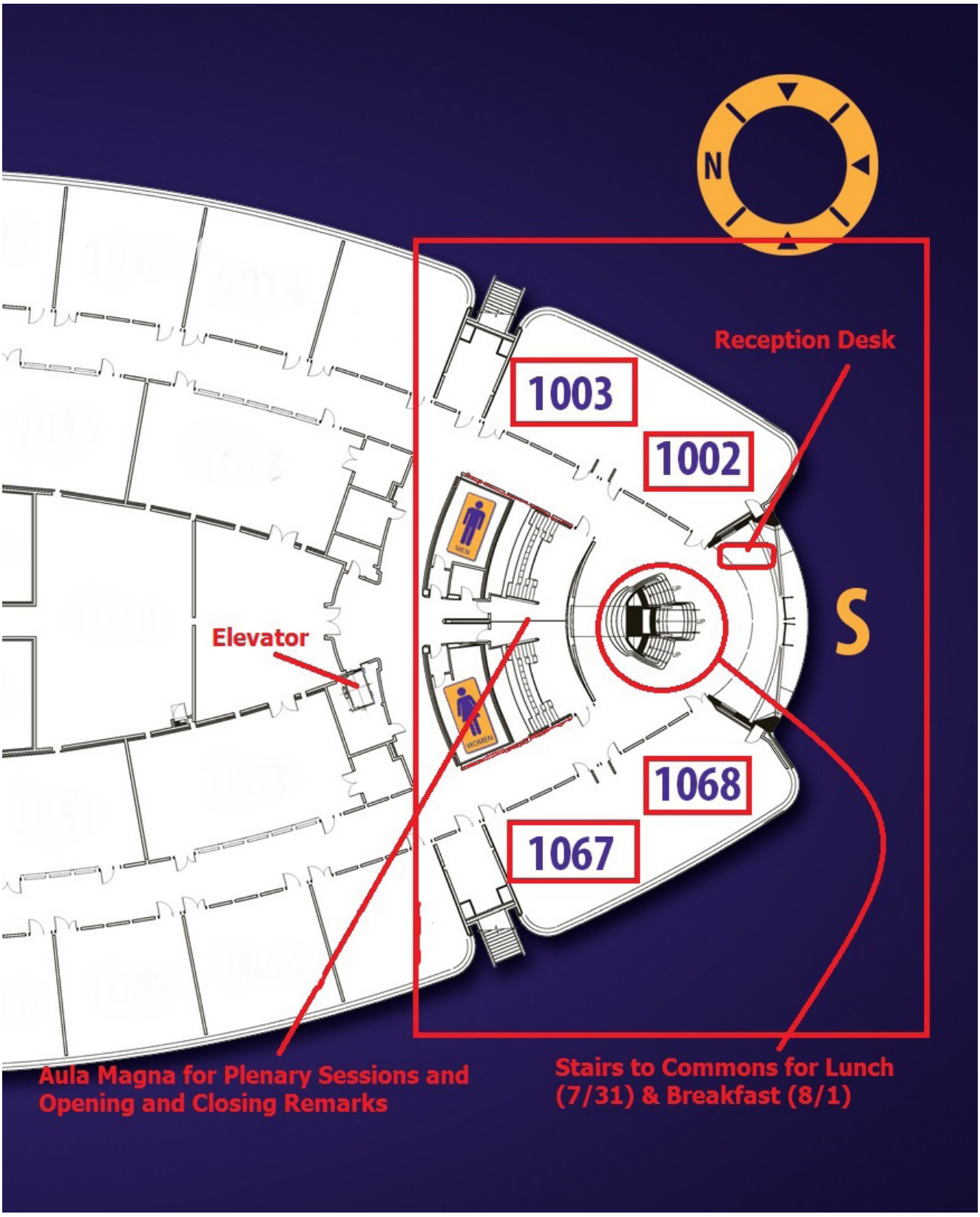
MAP OF SESSIONS ROOMS

SOUTH ENTRANCE OF IST BUILDING



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FLORIDA POLYTECHNIC UNIVERSITY

2017 Renewable Energy Systems and Sustainability Conference

Lakeland, Fl.

Florida Energy Systems Consortium