The Florida Energy Systems Consortium (FESC) Overview Presentation

by

Canan Balaban, Associate Director

NASEO Annual Meeting
October 6-8, 2020

Outline

- Background About the Consortium
- FESC Leadership Structure
- Research Thrust Areas
- Technology Commercialization
- Education and Outreach
- Selected Research Projects
- Accomplishments

FESC
Florida Energy Systems Consortium

Florida Energy Systems Consortium (FESC)

Created by Florida Statute in 2008 with $38M funding from State

Purpose:

- To unite Florida energy experts, including Florida's 12 universities, so that the state leads in energy research and develops innovative energy systems
- To promote improved energy efficiency, innovative energy technologies, and expanded economic development

Florida Energy Systems Consortium

Florida Energy Systems Consortium Members

Guest Members:

- Florida Institute of Technology (FIT)
- University of Miami

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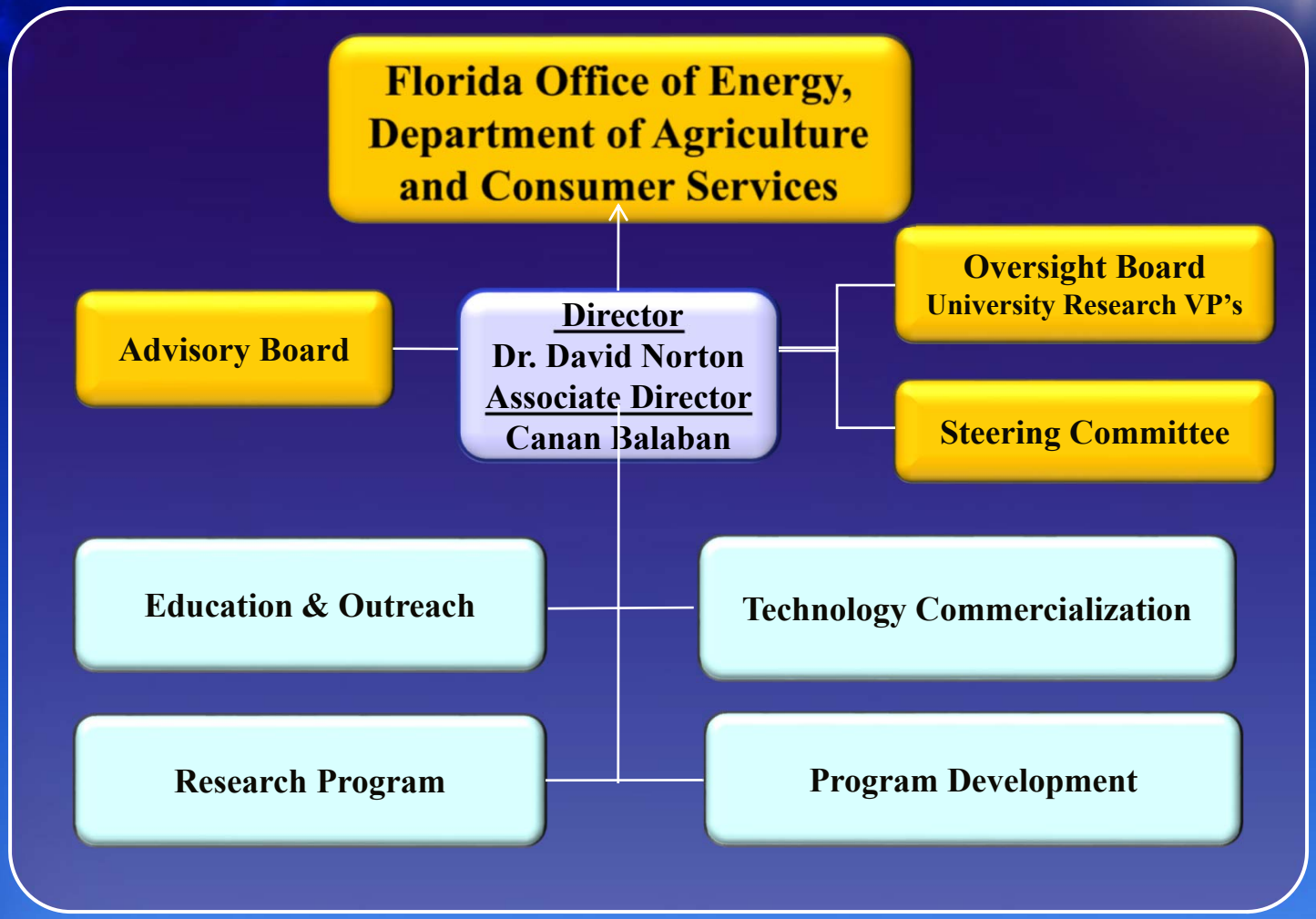
FESC Leadership Structure



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FESC Advisory Board

1. Buck Martinez, Chair of the Board, President, 27 Consulting
2. Ben Amaba, Chief Innovation Officer, IBM
3. Tommy Boroughs, Attorney at Law
4. Timothy Bryant, NextEra Florida Renewables
5. Gustavo Cepero, VP, Florida Crystals Corporation
6. Sam Choi, Manager, Orlando Utilities Services
7. Christopher Fountas, Partner, Arsenal Venture Partners
8. Nicholas C. Gladding, P.A. Attorney at Law
9. Tom L. Hernandez, Sr. VP, Tampa Electric Company
10. Dan Holladay, Director – Research & Commercialization, UCF
11. Tom Lawery, Wholesale Renewables Manager, Duke Energy
12. Roy A. Periana, Director, Scripps Energy Laboratories
13. Jeremy L Susac, VP Government Affairs, Lennar Ventures
14. Paul Zombo, Manager, Siemens Energy, Inc.

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FESC Steering Committee Members

- **David Norton, FESC Director,** VP for Research, UF
- Charles Weatherford, Professor and Chair, FAMU
- Gabriel Alsenas, Director, Southeast National Marine Renewable Energy Center, FAU
- Osama Mohammed, Prof. & Associate Dean of Research, FIU
- William S. Oates, Professor, FSU
- Issa Batarseh, Professor and Director, UCF
- Colleen Kettles, JD, Acting Director, Energy Systems Research & Education, UCF/FSEC
- John Kantner, Assistant VP for Research, UNF
- George Philippidis, Associate Dean of Research & Director of Sustainable Energy, USF
- Yogi Goswami, Co-Director, Clean Energy Research Center, USF
- Dr. Tarek Youssef, Assistant Prof., UWF
- Florida Gulf Coast U. & Florida Polytechnic University: TBD

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Florida Energy Systems Consortium (FESC)

Strategic Activities

- Research
- Technology Commercialization
- Education and Outreach

FESC involves

- Over 400 Faculty
- Over 1000 Graduate Students
- Over 200 Industry Partners

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Strategic Research Thrusts

- Developing Florida's Biomass Resources
- Harnessing Florida's Solar Resources
- Capturing Florida's Marine Energy Resources
- Securing Energy Delivery Infrastructure and Energy Storage
- Nuclear Energy (Education) & Carbon Capture
- Enhancing Energy Efficiency & Conservation
- Understanding Florida's Energy Systems

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Technology Commercialization Program

- **Two Tiered Model**
  - Early vetting of technologies for path to market
  - Proven model for spawning long-term collaborative R&D
  - Engage industry in development process in the university
  - Natural pipeline of technology deployment to private sector

- **Phase I:** Early Stage Market Research / Business Plans – Funds for business plans or market research studies at $10K each for later stage technologies.

- **Phase II:** Matching Funds R&D Program – Up to $50K / project for later stage projects with a 2:1 industry match

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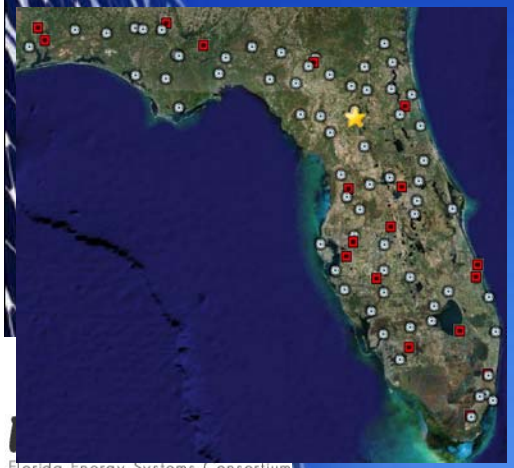
Education & Outreach

Education

1. Training for workforce development
2. Nuclear Engineering Education
3. Masters Level Education

Outreach

- Targets the general public & built environment
- Collaborates with the home builders and construction industry



Created over 50 Fact Sheets

Conducted technical & continuing education programs

Partnered with utilities to implement performance-based demand side management programs

FESC Funded Projects

- FESC state funding was awarded to 5 universities:
  - University of Florida administers the consortium
  - Other Funded Universities: FAU, UCF, FSU, USF
- Steering committee members decided how to distribute the funding at each funded university
- Total of ~80 projects were funded consortium wide and completed by the end of 2013.

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Proposal Teams to get External Funding

- **Formed faculty teams in the following expertise areas:**

  Energy Efficiency, Solar PV, Solar Thermal, Biomass, Feedstock, Algae, Carbon Capture, Smart Grid, Energy Storage, Marine Energy, Cyber Security, Small Molecules to Energy (solar fuel), Fuel Cells, Hydrogen, Catalyst, Nuclear Energy, Fusion, Sensors, Nano Materials, Climate, Education, Outreach

- **Track funding opportunities and share them with these teams and/or FESC Steering Committee members**

- **Assist faculty to form proposal teams.**

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FESC Sustainability after 2013

- FL Office of Energy funds:
  - $175,000 in 2014 with matching funds from UF
  - $,88,000 in 2015
- After 2015 -Administrative Support from UF:
  - Director does not get any salary
  - Associate Director is supported by UF Research VP office.
- Research Support via Grants from Federal Agencies and/or other funding sources.

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Selected Current Research Programs within the Consortium

Potential Collaboration Opportunities

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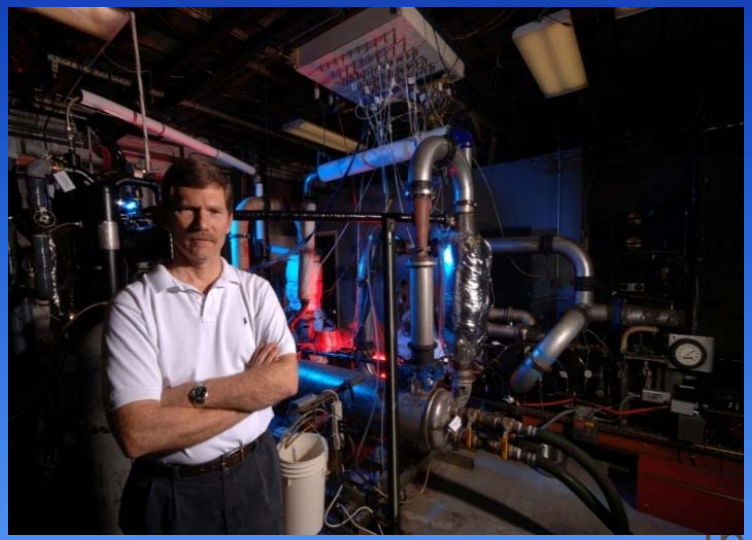
FESC Bio Energy Research Areas

- Energy Crops
- Algal Research
- Biomass Conversion Technologies
  - Biochemical
  - Thermochemical
- Catalyst Development
- Computational Studies



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Southeast Partnership for Advanced Renewables from Carinata (SPARC)

- PI: David Wright, University of Florida
- Total Funding: $14.8 million
- Partners: USF, FAMU, U of Georgia, NC State, MS State U, CO State U, Auburn U, NuSeed, Applied Research Associates
- Sponsor: USDA
- Goal: Establish a *Brassica Carinata*-based resilient and sustainable advanced jet fuel and bioproducts supply chain in the Southeast United States
- Link: http://www.sparc-cap.org/

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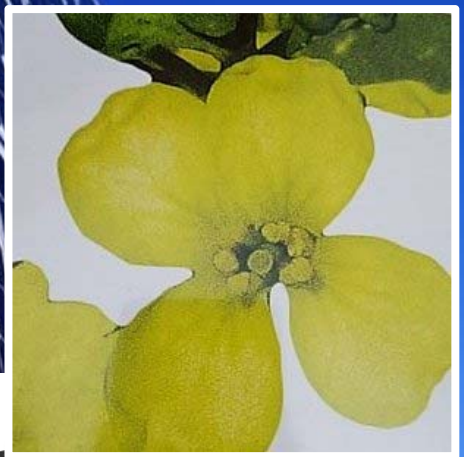
Carinata Fields and Seeds



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Evaluation of Energycane for Bioenergy and Sustainable Agricultural Systems (EC-BioSALTS)

- PI: Hardev Sandhu, UF
- Sponsor: US DOE and Total Funding: $4 million
- Partners: Argon National Lab, Lanza Tech, Commercial Aviation Alternative Fuels Initiative (CAAFI); Collaborators: USDA-ARS, Tifton, GA, FL Office of Energy, FESC
- Goal: To develop a bioenergy feedstock production system using an advanced energycane cultivar in marginal agricultural lands of the Southeast coastal plains

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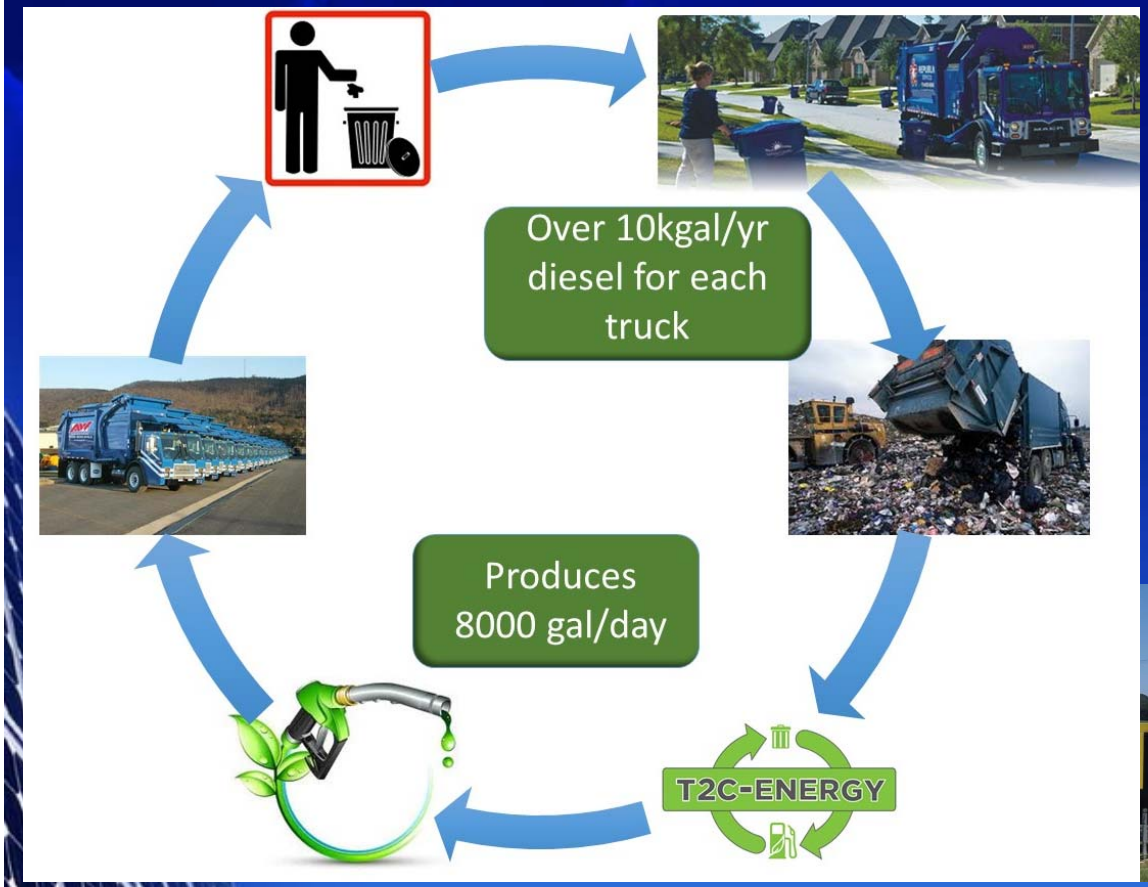
LANDFILL GAS TO DIESEL FUEL (USF/T2CE)



PI: Profs. Kuhn and Joseph

USF startup: Funding from DOE, FDACS, Hinkley Center, Florida High Tech Corridor; www.t2cenergy.com

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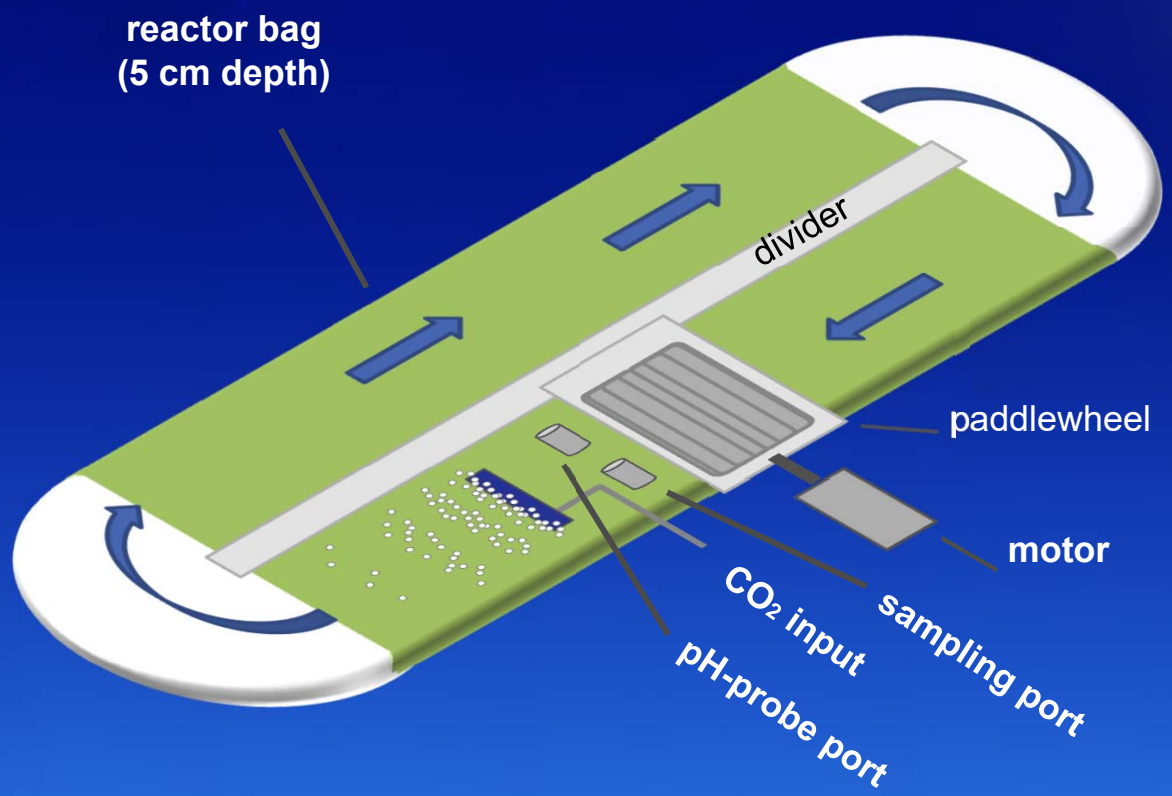
Innovative Algae Cultivation Technology at USF



Funding provided by FDACS and private sector

- Low capital cost
- Low water and energy use
- High productivity
- Readily scalable (modular)

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Innovative Algae Cultivation Technology at USF - Algae Cultivation Scale-Up

Funding provided by FDACS and private sector

Low-cost scalable sys

Dry microalgae
(plastics, ink, fish meal)

Nutraceuticals
(Omega-3 fatty acids)

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Solar Energy Research Focus Areas

- Design, Construction and Operation of Concentrated Solar Thermal Power Plant - Operational
- Low Cost CIGS Thin Film PV & Organic PV
- PV Panel-mounted Micro-inverter

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Solar Thermal Power Plant at USF

By Dr. Yogi Goswami

A row of parabolic trough solar collectors

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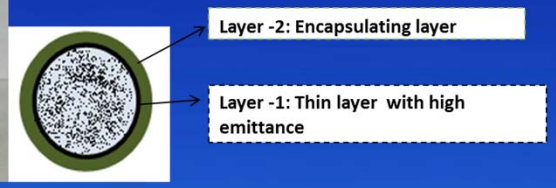
Solar Thermal Power Plant at USF

Solar Field for 50 kW_e Power Generation

High Temperature Thermal Energy Storage

Develop very low cost, industrially scalable capsules of PCMs for utility scale TES for CSP plants at temperatures from 600°C to 1000°C

- Use of high temperature PCMs with tailored radiative properties that enhances the heat transfer in the PCM
- Macro-encapsulation of PCMs to increase heat transfer area per unit volume



Ceramic encapsulated Phase Change Materials (PCM)

CERC
Clean Energy Research Center

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Solar PV Research at UCF – Dr. Kristopher Davis

Research Team develops new materials, manufacturing processes, and characterization techniques for photovoltaic cells and modules:

- Thin film deposition and semiconductor device fabrication
- Characterization of thin films and interfaces
- Surface passivation materials for semiconductors
- Development of carrier-selective materials and heterostructures
- Optical materials and photon management in optoelectronic devices
- Characterization of photovoltaic cells and modules
- Defect detection and root cause analysis in photovoltaics
- Reliability and durability of photovoltaics
- Modeling and simulation of optoelectronic devices

Link: http://mse.ucf.edu/davis/

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Securing Energy Delivery Infrastructure

- **Smart Grid Demonstration Project at USF in collaboration with Duke Energy**
- **Micro-grids at various universities**
- **Real Time Digital Simulations (RTDS):** By FSU Center for Advanced Power Systems
- **Grid Security**
- **Power Electronics, Micro Invertors**
- **Power Systems**
- **Energy Use Behavior**

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Foundations for Engineering Education for Distributed Energy Resources (FEEDER) Consortium

- PI: Dr. Zhihua Qu, UCF
- Total Funding: $3.2M in 2013 and $1M in 2016
- Partners: FSU, UF, UC San Diego, U of SC, U of Pittsburgh, U of Hawaii, UT at Dallas, and more
- Sponsor: US DOE
- Goal: To develop the engineering capability to accelerate the deployment of distributed renewable energy technologies onto the electric utility grid
- Link*: http://www.feeder-center.org/index.php*

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Foundations for Engineering Education for Distributed Energy Resources (FEEDER) Consortium

12 Universities

University of Arkansas
Auburn University
The Florida State University
University of Hawai'i
University of Kentucky
University of Pittsburgh
San Diego State University
UC San Diego
University of South Carolina
UT Dallas
UCF
UF University of Florida

18 Utility Partners
2 National Labs (NREL and Los Alamos)
10 Supporting Industry Partners

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Florida Power Electronics Centre, UCF – Dr. Issa Batarseh

Research Areas:

- Power Electronics
- Solar Energy Conversion
- Grid-tied Inverters
- DC converters operations and Control
- Three port multilevel converter

Projects:

- Three Port Converter Based on Dual Active Bridge Topology
- Highly Integrated Grid-Tied Multi-Port Power Module for PV And Storage (Ipv++)
- Power Electronics Converters for Wide Input Voltage and High Voltage DC Bus Applications
- Gallium Nitride (GaN)-Based Three-Port Power Inverter (can process high voltage and current using low voltage rating switches).

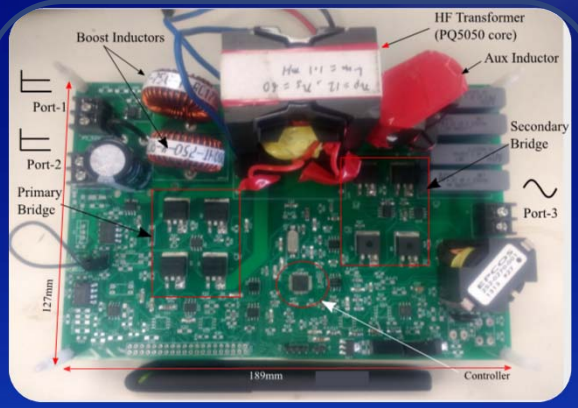

Fig.1 . Prototype of three port dual active bridge converter

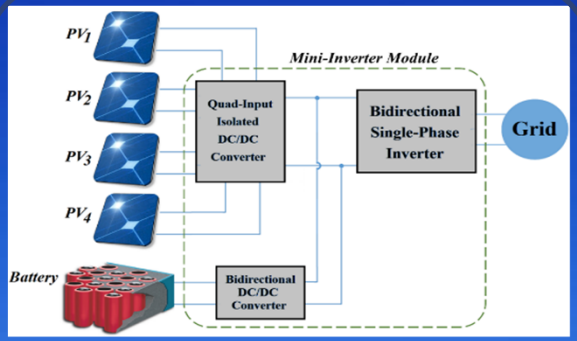

Fig.2 . System level configuration of the proposed iPV++ architecture

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Securing Communication Messages in Smart Power Systems (Hardware Cyber Security)

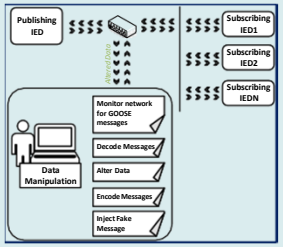
FIU Engineering & Computing

Objective: Developing security algorithms to **protect**, **detect**, and **respond** to attacks on IEC 61850 GOOSE messages within the walls of a substation and IEC 61850 R-GOOSE messages between substations.

Security threats:

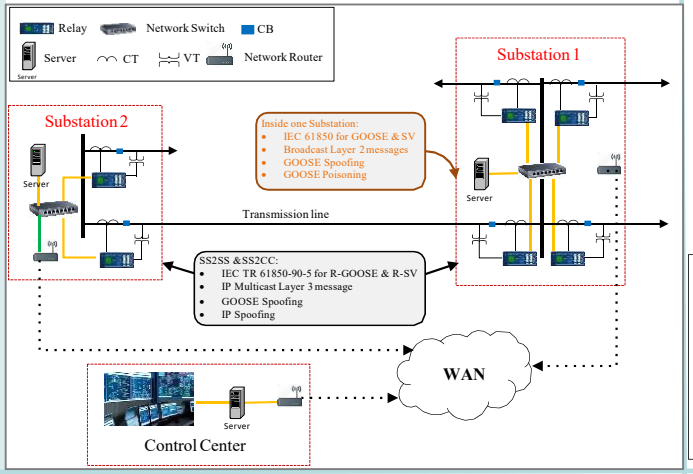
1- Inside a substation:

data manipulation
GOOSE Spoofing
GOOSE poisoning.

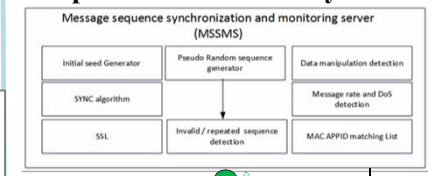


2- between substation:

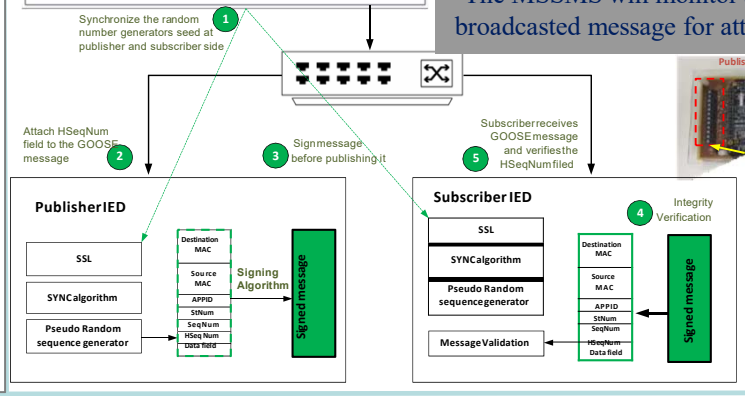
IP spoofing
BAD data Injection

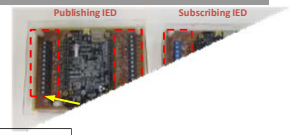


Proposed Solution for layer 2: Sequence Hopping Algorithm



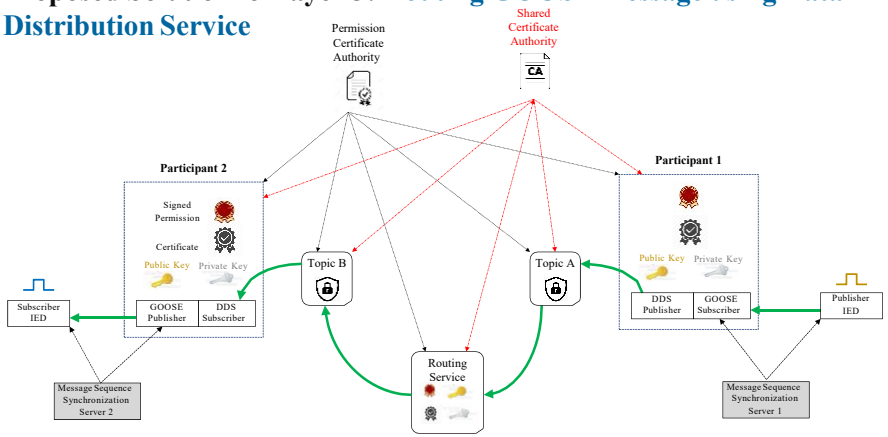
-Message sequence synchronization and monitoring server (MSSMS) will communicate with agents.
- MSSMS will generate initial seeds.
-The MSSMS will monitor all GOOSE broadcasted message for attack detection.





Security algorithm is very fast and is within the 4 ms time limit.

Proposed Solution for layer 3: Routing GOOSE message using Data Distribution Service

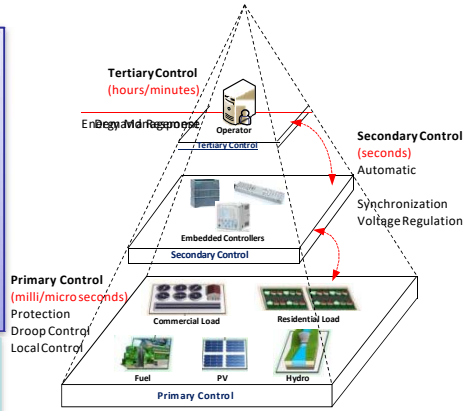


- In this algorithm, basically a GOOSE message encapsulated in a Layer 3 IP packet.
- This package is sent over the wide are network (WAN) to its destination.
- Security of this package is provided by Securing the DDS framework.

Educational aspects of the project: Development of an Interactive Class-based Curriculum with hands-on Laboratory Experimentations for Energy Cyber-Physical Infrastructure.

The goals:

1. Educating current users of CI technologies.
2. Enhancing problem-solving skills.
3. Promoting experimental for applying existing technologies to new uses.



This project is divided into two parts:

1. **The first part is class based**
2. **Second is laboratory experiments.**

Project POC: Prof. Osama Mohammed
mohammed@fiu.edu, 305-348-3040

Distributed Machine Learning Algorithms for Secure Operation of Autonomous Critical Infrastructures

FIU Engineering & Computing

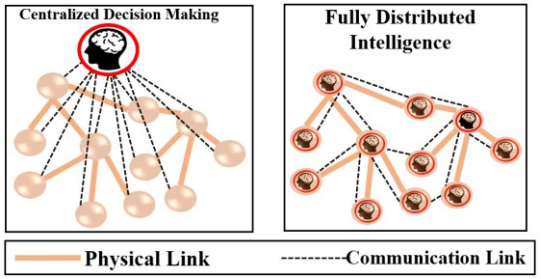
Objective: optimal and **secure** operation of autonomous internet of things using **distributed machine learning**

Current Issues:

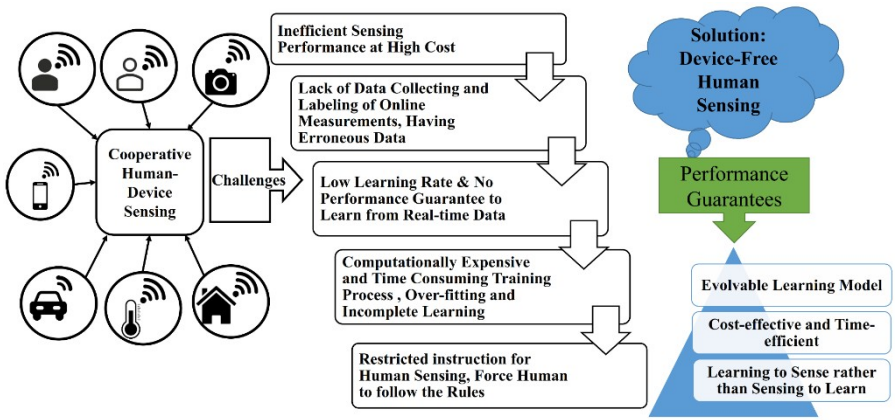
- **Complexity**, current algorithms are computationally expensive
- **Scalability**, their complexity increases with number of IoT devices
- **Security and Privacy,** all agents need to share their private data with fusion centers

Proposed Solution:

- Distributed Intelligence
- Local Information Exchange
- Scalable Computing
- Preserving Security and Privacy of Decision Making Agents



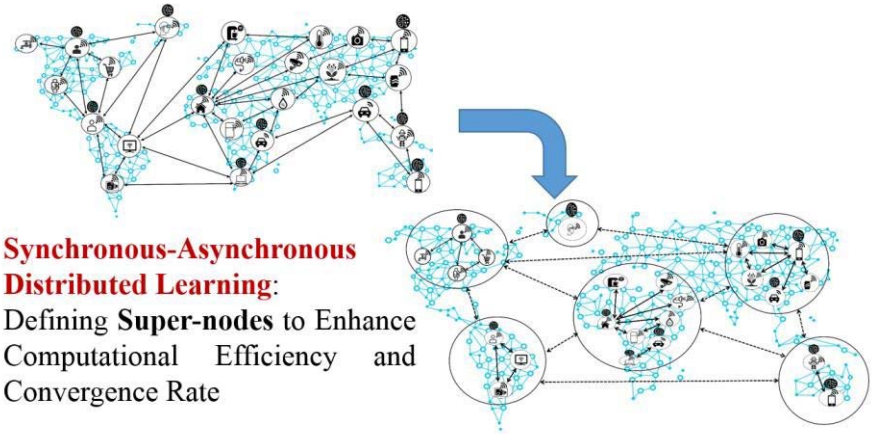
Addressed Challenges: "Learning to Sense" replaces "Sensing to Learn"



Impact: Distributed machine learning outperforms classic centralized solutions in many aspects:

	Centralized	Distributed
Information Privacy	All information of agents	Limited local information exchange
Problem Size	Large number of variables	Small number of variables at each local problem
Computation Time	High	The computation overhead is distributed over agents
Scalability	Complexity increases with scale	Scalable without increasing the complexity
Online Tracking	Requires extensive computation	Fast plug-and-play and tracking capabilities

Applications: Real-time Decision Making and Sensing in Networked Drone Swarms, Energy Networks, Intelligent Transportation Networks, and Healthcare Applications



Synchronous-Asynchronous Distributed Learning: Defining **Super-nodes** to Enhance Computational Efficiency and Convergence Rate

Contact: M. Hadi Amini, Ph.D., D.Eng. moamini@fiu.edu

Southeast National Marine Renewable Energy Center
Florida Atlantic University (FAU)

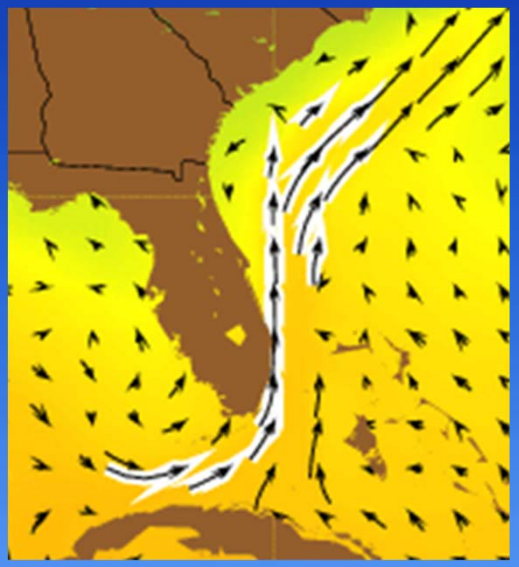
U.S. Department of Energy Center

and

State of Florida Center of Excellence designated at FAU

Founding Member: Florida Energy Systems Consortium

Research Focus: Marine and Hydrokinetic (MHK) Renewable Energy to harnesses ocean current energy to generate electricity



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Fostering University, Industry and Public Partnerships to Create an Ecosystem for Energy Market Development

- Federal, state, and local R&D support

Public Investment

Private Investment

- Renewable energy project developers
- Independent investors

Industry Technology

- Turbine manufacturers
- Component and sub-system manufacturers

Market Development

- **R&D and testing support to advance technology maturities**
- **Influence policy and regulatory climate**
- **Build public interest and outreach**
- **Train workforce for new sector**

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OceanBased Perpetual Energy

OCEAN CURRENT ENERGY

FAU SOUTHEAST NATIONAL MARINE RENEWABLE ENERGY CENTER

Example 1 (2017-2020):

- Federal support administered by FL Office of Energy to demonstrate OCE, LLC turbine innovations by SNMREC (REET Program)
- SNMREC direct federal support to develop onshore and offshore test infrastructure
- Private developer OceanBased uses both to demonstrate 24 hr. continuous power generation of Gulf Stream

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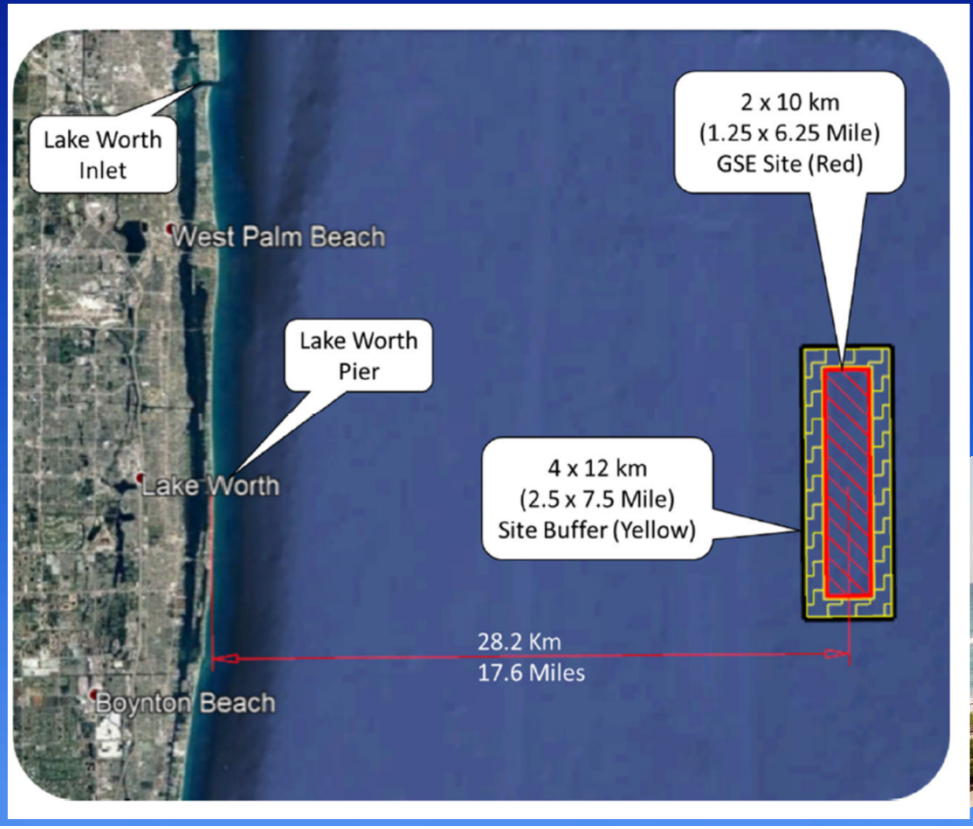
Example 2 (2017-ongoing):

- City of Lake Worth Beach with municipal utility develops vision to establish regional innovation hub for marine energy in southeast Florida
- Partners with SNMREC and consultants to develop economic impact assessment and preliminary scoping study for offshore grid connection to technology incubation site
- Seeking state and federal support to begin detailed planning and design

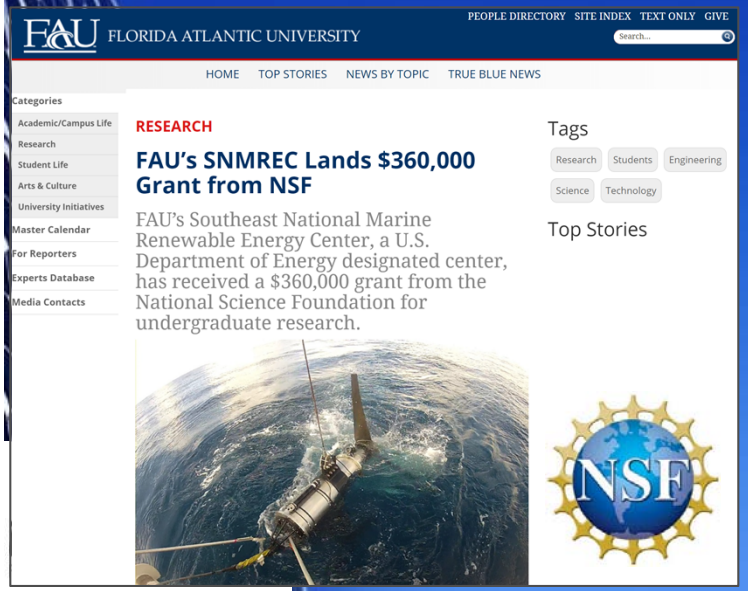


$90M
Annual Regional Economic Impact

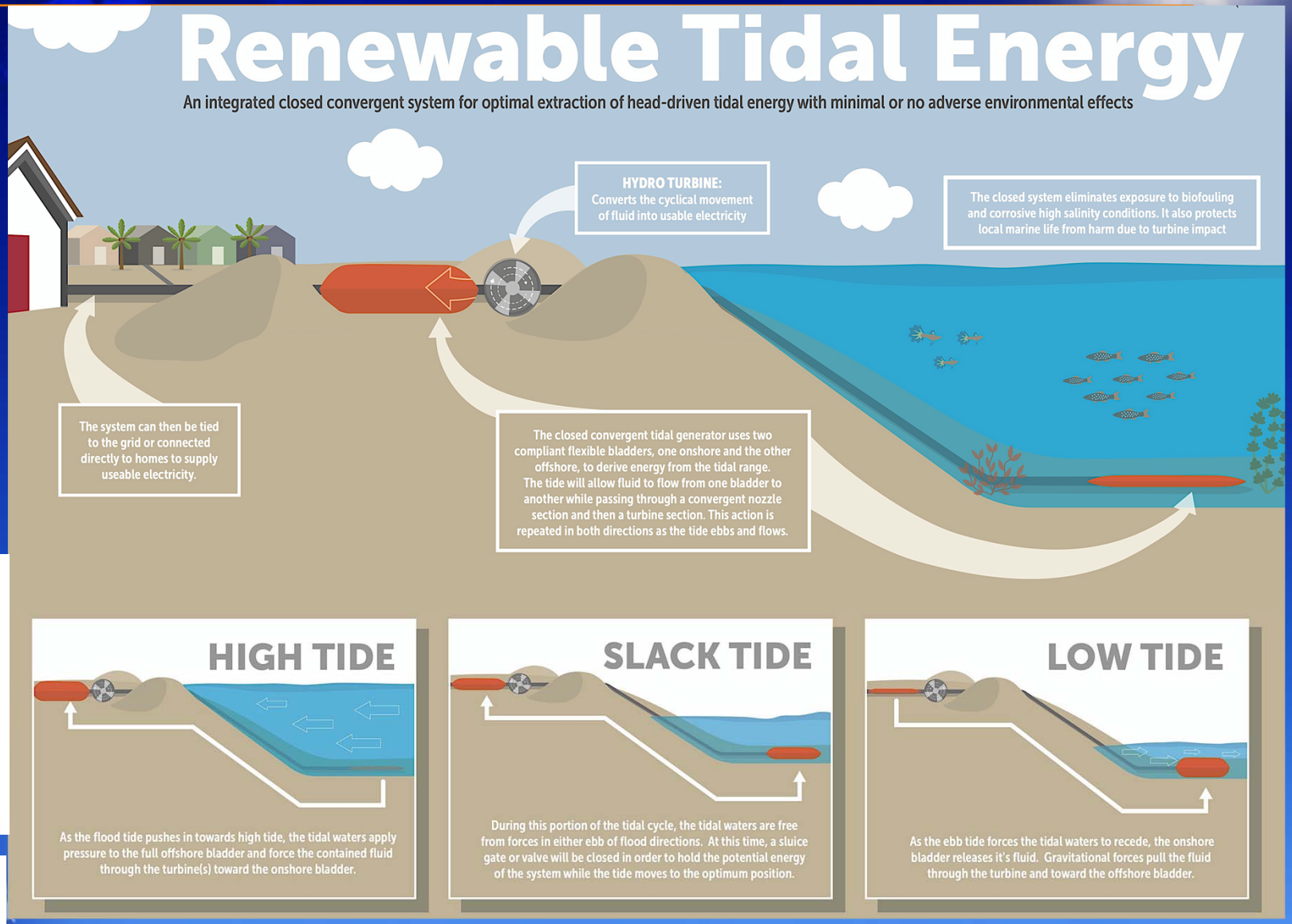
500+
Permanent Jobs

Example 3 (2017-ongoing):

- State and federal support develops 10+ years of graduate and undergraduate researcher training (over 100 students) for new sector
- Dr. James VanZwieten secures summer program from NSF that trains top university undergraduates from around U.S. in marine energy
- Summer 2020 completed year 1 of 2nd 3-year award despite COVID restrictions



Renewable Tidal Energy at UNF



UNF
UNIVERSITY of NORTH FLORIDA.

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Florida A&M Center for Plasma Science and Technology
Charles Weatherford, Ronald Williams, Lewis Johnson, Carol Scarlett

- **High Performance Simulation of Quantum Control of Laser Plasma Coupling (STPX for fusion)**
- **Muon Catalyzed Fusion (High Energy Density Science for Inertial Confinement Fusion)**

FAMU SPHEROMAK and the Turbulent Physics Experiment (STPX). Left –Baysha Bernales (physics junior); Roght – Brandon Alexander (lead technician)

Muon-catalyzed fusion (μCF) is a process allowing nuclear fusion to take place at temperatures significantly lower than the temperatures required for thermonuclear fusion. It is one of the few known ways of catalyzing nuclear fusion reactions. Muons are unstable subatomic particles.

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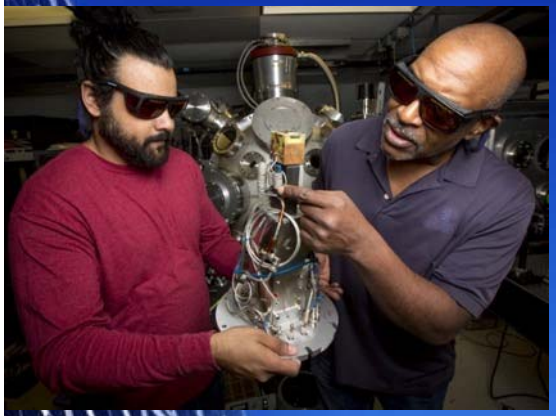
Collaboration with Lawrence Livermore on High Energy Density Science (HEDS)

Livermore Lab FOUNDATION



- **LLNL points of contact**
  - Tony Baylis, Strategic Diversity and Inclusion Programs
  - Dr. Frank Graziani, Director, HEDS Center
  - Dr. Ronnie Shepherd, Atomic physics in dense plasmas,
  - Dr. Jim Trebes, Physics Division Leader
- **FAMU HEDS experimental and computational collaborative projects (4)**
  - Drs. Daniel Gebremedhin (Weatherford's FAMU postdoctoral fellow) is conducting research at LLNL
  - Jerry Clark is doing thesis research under Dr. Shepherd conducting experiments at Colorado State University
  - Yaye Badjo (Saha's FAMU PhD std) doing thesis research with Dr. Bonev (LLNL)
  - Jessica Tucker (Weatherford's FAMU PhD std) doing thesis research with D. DuBois (LLNL)
- **Internship opportunities (2) at LLNL for FAMU CfHEDS**

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Enhancing Energy Efficiency & Conservation

- **Net –zero or energy efficient demonstration homes at multiple campuses** - UCF, FSU, USF, FIU, UWF: Used for research, training, outreach.
- Residences consume more than 40% of Florida's electricity

Flexible Residential Test Facility at FSEC

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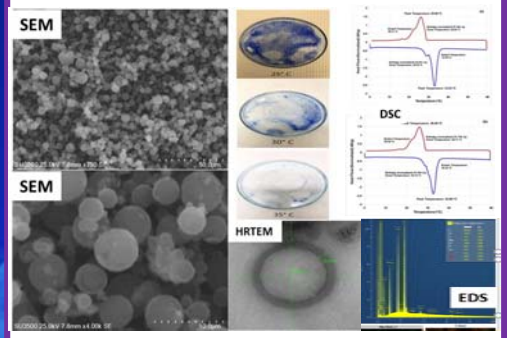
Microencapsulation of Thermochromic Materials for Energy Savings Applications

Elias Stefanakos, Director of CERC and Professor of Electrical Engineering(estefana@usf.edu)
Sesha Srinivasan, Assistant Professor of Physics, Florida Polytechnic University (ssrinivasan@floridapoly.edu)

The focus of this collaborative research is to develop microencapsulated thermochromic materials [TCM] (core@shell nanostructures) for energy saving applications in buildings. Carry out R&D on electrospun TCM fibers for textile related applications.

Core@Shell encapsulation

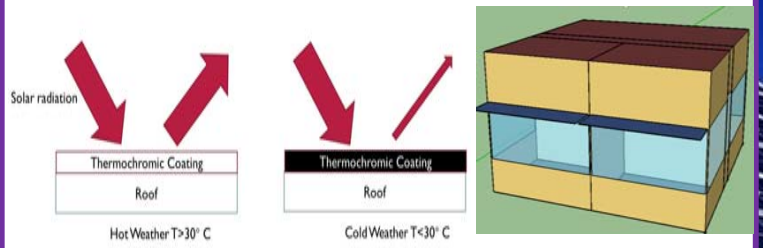
Develop Metal Oxide nanoparticles encapsulated TCMs



Abdullatif Hakami et. al., IJMSE, 2020
ICAFM 2020 Conference Proceed.

Applications of Encapsulated Thermochromic Materials

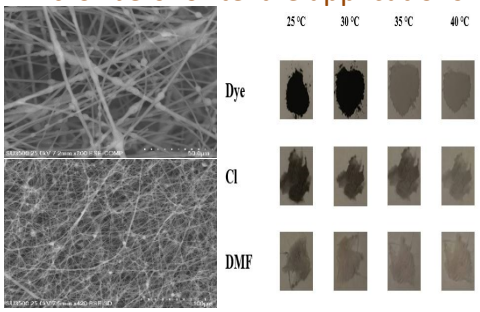
TCMs advantages for roof coating or heating to save energy consumption of buildings



Ram Manoj and Elias Stefanakos (2020) USPTO US20200079993

Electrospun TCM Embedded Fibers

Develop TCM embedded polymer microfibers for textile applications



Keon Sahebkar et. al. J. Indu. Text. (2020)

- MRS Conference, Boston (2019)

Advancing Alternative Fuel Vehicles in Florida

Develop a strategic plan for the coordinated deployment of alternative fuel vehicles and infrastructure across Florida.

- Statewide Program Funded by US DOE
- Identify Barriers to Deployment
- Propose Initiatives to Overcome Barriers
- Safety and Fleet Training
- Fleet Recognition

FLORIDA Alternative Fuel Vehicles

Partners: Project lead – UCF FSEC's Central Florida Clean Cities Coalition; Subrecipient – USF's Tampa Bay Clean Cities Coalition

FESC Florida Energy Systems Consortium

Accomplishments

FESC
Florida Energy Systems Consortium

FESC Research Successes

During 2009 to end of 2013:

- **Leveraged $38 million in state appropriation to obtain $425 million in energy research funding from third parties** Resulting dissemination of over 1000 publications and 1000 presentations – promotes Florida's energy capabilities and technical leadership helping to attract energy industry and energy funding to FL
- **Technology Licensed – 101 licenses**
- **Invention Disclosures – 459 submitted**

Startup Companies – 36 companies formed based on university developed technologies. 15 of them are active now.

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Florida Energy Systems Consortium

FESC Spin off Companies

#	University	Name of Business	Year Formed	Specialty
1	UCF	Garmor, Inc.	2012	Edge-Functionalized Graphene Oxide
2	UCF	HybridaSol, LLC	2012	PV-Thermo Electric Hybrid
3	UCF	Helicon Chemical Company, LLC	2012	Self-cleaning Coating Chemicals
4	UCF	Capacitech Energy, LLC	2016	Energy Storage in Cables
5	UCF	Advanced Power Electronic Corp. (ApECOR)	2016	Solar Energy Conversion and Integration Technologies
6	UCF	HySense Technology, LLC	2012	H_2 Sensing Tape (Acquired by Nitto Denko in 2018)
7	UF	Florida FGT, LLC	2010	Energy Crops
8	UF	NanoPhotonica, Inc.	2010	Optoelectronic Devices
9	UF	RedOx Power Systems, LLC	2010	Solid Oxide Fuel Cells
10	UF	Innovative Space Tech., LLC	2014	Solar
11	UF	SensorComm Technologies, Inc.	2014	Sensors to monitor NOx emissions
12	UF	Molekule Inc.	2015	Energy Efficient Air Purification
13	UNF	Sea's the Future Tidal Energy Systems, LLC	2018	Tidal Energy
14	USF	T2C-Energy	2012	Landfill Gas to Liquid Fuel
15	USF	SunBorne Energy, LLC	2010	Solar Installations in India

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Florida Energy Systems Consortium

FESC Successes – Education

Workforce Development - Program implementation with Florida Advanced Technological Education Center (FLATE).

- Created state-wide technician educational delivery system
- Developed two energy degree programs:
  - Alternative Energy Technologies
  - Industrial Energy Efficiency

- **Energy Education Programs at FSU, USF and UWF** and 5 New Energy Courses
- UF Nuclear Engineering Training Reactor
- Over 100 specialized *Industry* Training and Education Events

FLATE
FLORIDA ADVANCED TECHNOLOGICAL EDUCATION CENTER
A National Science Foundation Regional Center For Advanced Technological Education

FESC
Florida Energy Systems Consortium

FESC Successes - Outreach

- Focus on Energy Efficiency
- Over 50 Fact Sheets prepared to help Florida citizens better conserve and increase energy efficiency
- Utilized UF/IFAS Extension program to reach out public
- Sustainable Floridians program (8 week training program preparing Florida citizens to be ambassadors for sustainability) by Director of Program for Resource Efficient Communities (PREC).
- Bi-monthly e-newsletter till end of 2015
- Bi-annual reports till end of 2015
- FESC Annual summits till end of 2015
- FESC web site

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Florida Energy Systems Consortium

Summary of Activities/Accomplishments

- FESC has highly leveraged the state funding and linked Florida universities with Florida energy industry and continues to do so
- Gives Florida a competitive advantage in energy related research, job creation, workforce development
- Increased awareness nationally/internationally of FESC and its leadership role

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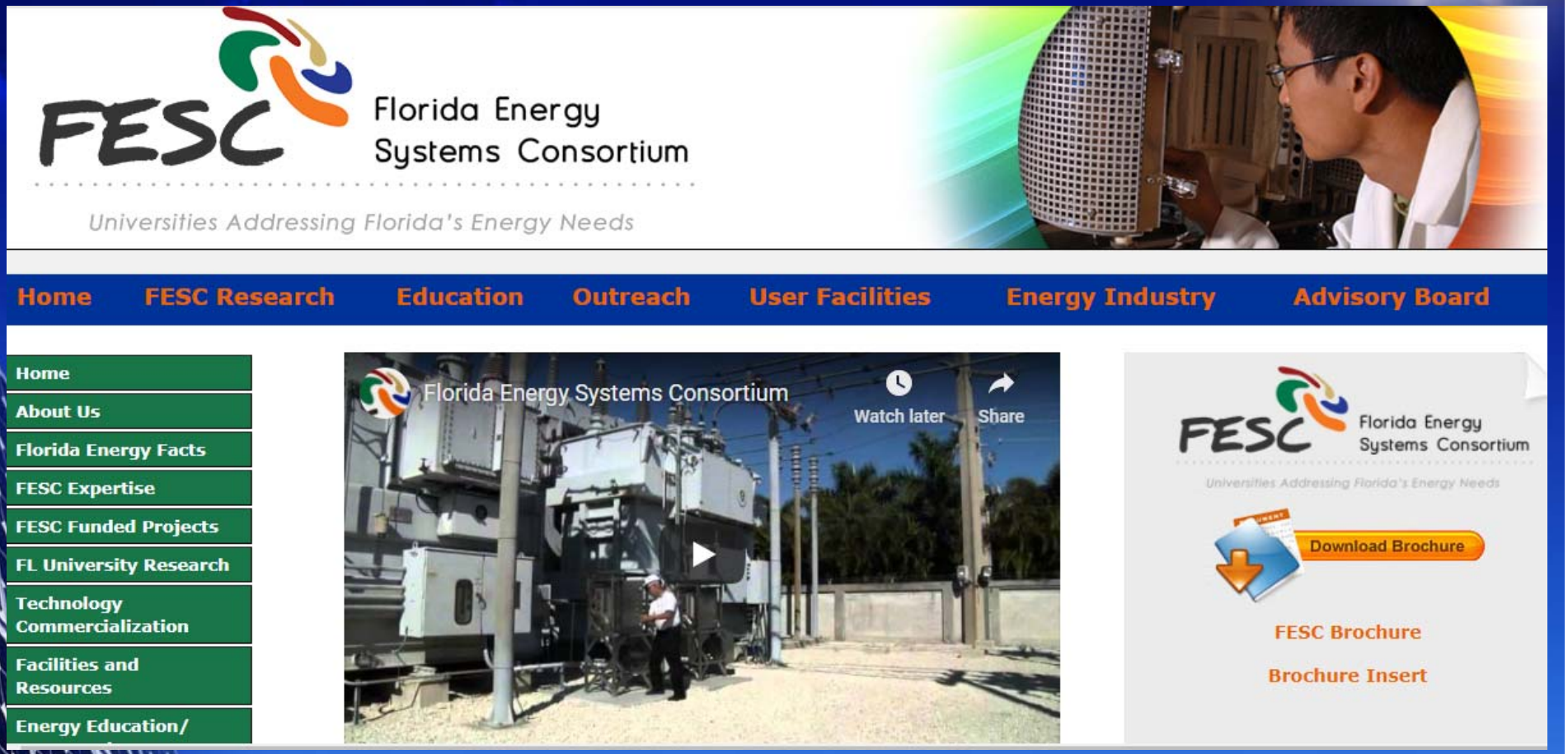
Content-Rich Web Site



http://floridaenergy.ufl.edu/

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Contact Information

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Extra Slides

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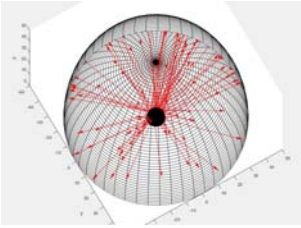
Selected ongoing efforts at FSU's Energy and Sustainability Center

Radiative cooling for power plants

Experimental setup

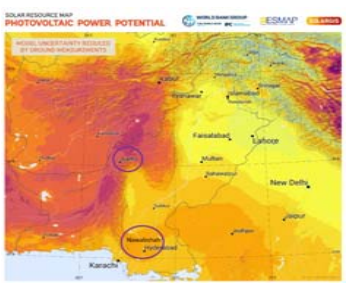


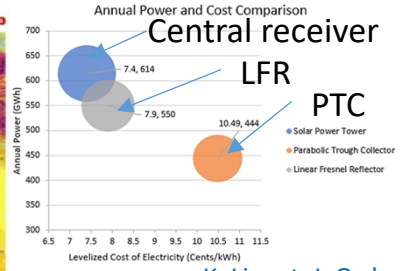
Ray-Tracing

Experimental and simulation efforts to evaluate effects of incorporation of radiative cooling into power plants

L. Porto, J.Ordonez

Comparative study of concentrated solar plants

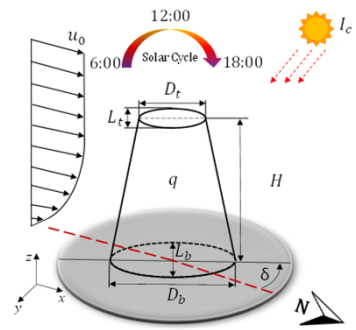




K. Liaqat, J. Ordonez

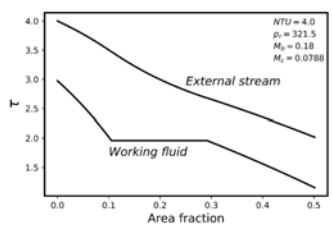
Resource and Land Slope assessment

Thermoregulation of natural structures



T. Fagundes, J. Ordonez, N. Yaghoobian

Rankine cycle internal area allocation for maximum efficiency

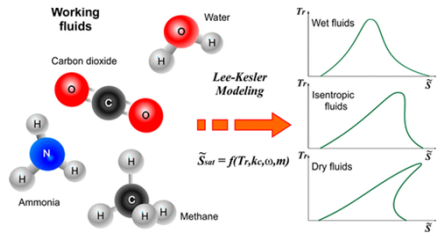


L. Porto, J.V.C. Vargas, J.Ordonez

North Florida –Georgia DOE Industrial Assessment Center

J. Ordonez, O. Faruque

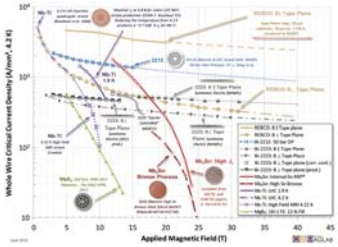
Generalized thermodynamic modeling for organic fluids using a Lee-Kesler framework



A.Rivera, O. Abakporo, J, Osorio, R. Hovsapian J.Ordonez

Sample of Research Energy Related Projects at FSU

- Nb3Sn Superconductors for the LHC and for Accelerators Beyond the LHC
- A Route to Molecular Quantum Technologies Using Endohedral Metallofullerenes
- Ultra-Rad-Hard Particle Detection for Modern Colliders
- The Impact of Grain Boundaries and Dislocation Substructures on Functional Properties of NB for SRF Cavities
- Efficient and Scalable Time-Stepping Algorithms and Reduced-Order Modeling for Ocean System Simulations
- Magneto-optical Study of Correlated Electron Materials in High Magnetic Fields
- Probing New Physics with Tau Leptons using the CMS Detector
- The Underlying Science of Round Wire Bi-2212
- Exposing the electronic properties of topologically non-trivial and correlated compounds: a quest for topological superconductivity
- Electromechanical Studies of Superconductors for DOE/HEP Applications
- Microwave spectroscopy of correlated 2d electron systems in semiconductors and graphene
- Liquid Helium Fluid Dynamics Studies
- Atomic Nucleus: A Finite Open Quantum Many-Body System
- Experimental hadronic nuclear physics
- The Underlying Science for Realizing High Critical Current Density in (Ba/Sr)Fe2As2 Fe-based Superconductor Wires.
- From Quarks to the Cosmos
- Unraveling the Transition in Periodicity in Late Actinides
- Nb3Sn Superconducting Cavities by Bronze Routes for Accelerator Stewardship
- Center for actinide science & technology an energy frontier research center



Materials -superconductivity

Cryogenics

Renewable energy

Advanced Power Systems

Research & development of environmentally clean energy systems at USF

CERC
Clean Energy Research Center
University of South Florida

Key research projects include:

- Photocatalytic disinfection of air and water
- New efficient thermodynamic cycles
- Thermal Energy storage
- Concentrating solar power (CSP)
- Photovoltaics
- Solar water desalination
- Smart materials: Thermochromic, Electrochromic
- Biofuels
- Biowaste to energy

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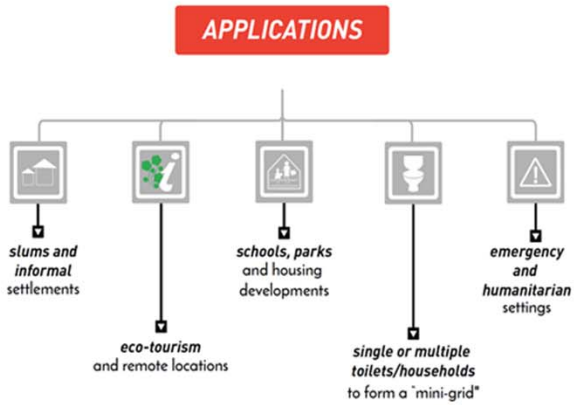
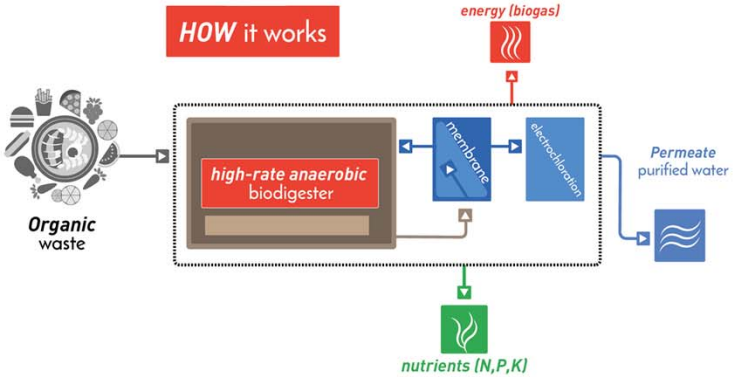


UNIVERSITY OF SOUTH FLORIDA

NEWgenerator™
resource recovery machine™



Advanced onsite wastewater treatment and resource recovery (recycled water, biogas energy, nutrients for fertilizer)

Operates off-grid 100% on solar PV

Compact, mobile, automated, remote operation, instant infrastructure

Operated in India, South Africa, Florida

Funding: Bill & Melinda Gates Foundation "Reinvented Toilet" program, USEPA, NSF

Award-winning: Cade Prize for Innovation, USPTO Patents for Humanity Award

Commercialization: licensed to companies in India and South Africa; startup (BioReNEW, inc); seeking strategic partners

www.NEWgenerator.net

Prof. Daniel Yeh, College of Engineering (dhyeh@usf.edu)

Organic Processor Assembly (OPA): Next-generation water recycling technology which recycles organic wastes (fecal, food waste) into fertilizer to enable crop production in space

Aim is to achieve closed-loop bioregenerative recycling of all wastes to enable sustainable operation of Lunar and Martian habitats

Hybrid system with biological and physicochemical treatment

Currently tested at Kennedy Space Center, with funding from NASA Advanced Explorations Systems (AES)

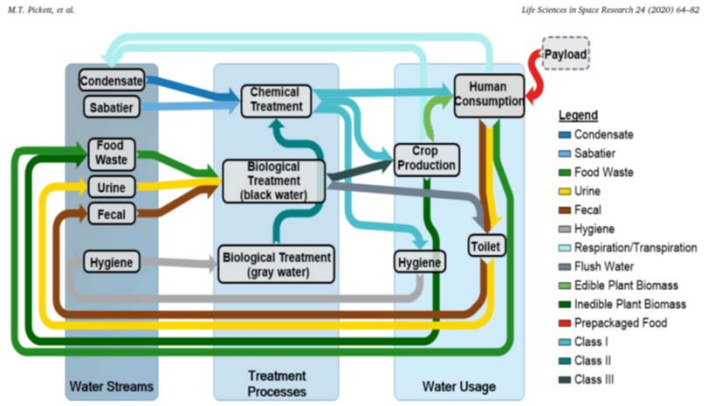


Fig. 5. Potential water cycling scheme using a combination of treatment processes to produce fit-for-purpose recycled water streams: Class I is potable grade, Class II is sanitized but non-potable, Class III is sanitized irrigation water containing nutrients.

Prof. Daniel Yeh, College of Engineering (dhyeh@usf.edu)