FESC
Florida Energy Systems Consortium

An Overview of the Florida Energy Systems Consortium (FESC)

Prepared for the Florida Energy and Climate Commission

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Table of Contents

OVERVIEW

The Florida Energy Systems Consortium (FESC) was formed by Florida statue to promote collaboration among the energy experts at the 11 State University System (SUS) universities for the purposes of sharing energy-related expertise and assisting in the development and implementation of a comprehensive, long-term, environmentally compatible, sustainable, and efficient energy strategic plan for the state. The Consortium was charged to '*perform research and development on innovative energy systems that lead to alternative energy strategies, improved energy efficiencies, and expanded economic development for the state'.* Importantly, the legislature appropriated $50M for a one-time investment in research at five of the SUS universities as well as support for education, outreach, and technology transfer. The Consortium is thus positioned to work with the Florida Energy and Climate Commission (FECC) to assist in developing and implementing the State's energy agenda.

The SUS has considerable energy-related expertise and competitively funded research, but very little research is being directed at integration. The FESC research plan is thus based on the ***premise that the overarching energy-related research and innovation opportunities are at the systems level.*** The proposed Consortium will not only aggregate our energy research expertise to leverage its value, but also enable the broad systems approach necessary to provide pathways to meet the State's energy needs. Six additional strategic research thrusts have been identified. The Consortium will focus on the use of its two most abundant renewable energy resources (biomass and solar), carbon-free electric power generation (nuclear power, carbon sequestration), tapping the energy available from the ocean along our long and populated coastline, reducing consumption through energy conservation and improved efficiency, and defining more efficient load management and energy storage systems.

Strategically, FESC has formed an enterprise to bring together the SUS experts to specifically focus on a systems approach with the governing bodies of the State as the primary customer. It is our vision that this enterprise will be the objective resource for the State for information and analysis to guide energy-related governance decisions. Both selected and recurring analyses will be performed to better understand our energy infrastructure. As examples, FESC faculty from FSU and UF have been working with the Office of Energy on methodologies to estimate GHG emissions for ethanol production from Florida-derived bio-feedstocks, and in another program a multi-university team has been working on analysis of carbon cap-and-trade models.

The broader FESC research agenda will target barriers to commercialization of energy systems, thus leading to economic impact. At the same time, FESC aims to establish several research areas in which our researchers are recognized as world leaders.

Education and outreach are critical components of our mission. FESC will strategically focus on workforce preparation for the Florida existing and emerging energy industry. Specifically, FESC will team with the Community College system to provide training at the technical level, while a masters of engineering degree will be developed at the university level. Both programs will make use of distance delivery. The outreach component will focus on implementing energy efficiency. This program will use the university extension

system as well as other venues to reach out the residents of the State to inform them of approaches to decrease their energy consumption. FESC will also develop training centers to work with builders and urban planners to implement energy efficient living and work spaces.

A management plan has been put in place and the key team members identified. Populating an Advisory Board is underway and discussions with industry and government partners are ongoing. FESC intends to take advantage of the existing technology infrastructure at our universities to effectively transfer our innovations to the market place.

Our quality of life, economy, standard of living, and security depend on clean, affordable, and reliable energy. With the increasing cost of fossil energy and its impact on global warming, the business of energy is rapidly changing. With its coastal geography and southern latitude, and abundant renewable energy resources, the opportunities for economic impact on the State of Florida are enormous.

RESEARCH PROGRAM

Research Vision:
The Florida Energy System Consortium (FESC) is a State resource that performs scholarly research and analysis of energy systems that will contribute to a sustainable energy economy for Florida. In formulating a research plan for FESC, it became obvious that while most current university research was focused on specific energy components, a research gap existed from a systems perspective. It was believed that combining expertise at the SUS universities would position university researchers to address energy systems in a manner not possible at a single university. Building on this observation, our stated vision is to *be a world leader in energy research enabled by a systems approach*.

The Florida Energy Systems Consortium was appropriated $43.75 million in the 2008-2009 budget to perform research in the energy arena, and an additional $6.25 million for education, outreach, technology transfer, and management. The research funding was designated for five SUS universities (FAU, FSU, UCF, UF, and USF) in equal amounts ($8.75 million). The FESC Steering Committee set a collaborative university research agenda that focuses on those areas that can most impact the State of Florida. This agenda has an overarching strategic research direction of understanding Florida's energy systems. By doing so, the Consortium will provide meaningful analyses to guide the development of a State strategic energy plan, identify opportunities for improved efficiency, and assess the impact of proposed changes, all of which will lead to more informed actions. In addition to this overarching strategy, FESC will focus its research directions in the following Florida-centered strategic areas:

Strategic Research Thrusts of FESC

- Enhancing Energy Efficiency and Conservation
- Developing Florida's Biomass Resources
- Harnessing Florida's Solar Resources
- Ensuring Nuclear Energy & Carbon Constrained Technologies for Electric Power in Florida
- Exploiting Florida's Ocean Energy Resources
- Securing our Energy Storage and Delivery Infrastructure

Overarching Strategic Research Thrust: Understanding Florida's Energy Systems:

The largest effort that will be pursued by FESC is systems analysis research. This thrust will provide a platform for each of the other thrusts and allow direct connection to the State's energy economy. It is planned to unite existing strengths in energy science and engineering with the recognized experts in other areas, including Law, Public Administration and Policy, Economics, Environmental Studies, Geography, Urban and Regional Planning, Information Systems, Social Sciences, and Media Arts. This group will assist Florida's governing bodies in the development and implementation of a comprehensive, long-term, environmentally compatible, sustainable, and efficient energy strategic plan. It will do so by performing selected and recurring analyses to provide objective and quantitative assessments. In addition, this team will help evaluate and identify critical energy

infrastructure, such as sighting, de-risking, capitalization, licensing, permitting, and governing. It will also evaluate alternative power delivery and transportation systems that can operate in more complex energy markets with a new and more diverse range of energy suppliers. Its systematic approach will consider all aspects of a proposed sustainable energy strategy to better understand unintended consequences.

Perhaps two examples of new activities initiated since the inception of FESC might help convey the vision of this thrust. The legislation that created FESC (House Bill 7135) also contains a mandate of 9 to10 % ethanol content in all gasoline (by volume) sold in the State by December 31, 2010. Further, the legislation requires development of an "average percentage" by which all renewable fuels will reduce life-cycle greenhouse gas emissions. FESC is working with the Office of Energy to evaluate the life-cycle greenhouse gas (GHG) emissions associated with ethanol used as a transportation fuel. The analysis will not only design a model to provide a reliable method to estimate the GHS emission reduction but also evaluate various Florida-based bio-feedstocks to guide the specification of the required percentage reduction. This project was made possible by creating a team of researchers from FSU and UF in engineering and crops sciences with the necessary expertise.

The second example is also based on a component of the recent legislation specifying the establishment of a cap and trade policy for carbon. Working with the DEP, a team from UF's Public Utility Research Center (PURC) and FSU's Center for Economic Forecasting and Analysis (CEFA) is providing an independent analysis of the potential impacts of the cap and trade scheme that is being developed by a consultant. The SUS group will provide a critical review of the consultant's analyses to ensure that the projections are based on valid assumptions and appropriate modeling techniques, are robust, and are properly interpreted. In addition they are also investigating alternative methods for developing projections and projected impacts. By engaging a FESC assembled team, expertise in Florida-specific energy characteristics and policy that has access to Florida-specific data will be used to provide objective and relevant analysis.

Importantly, Governor Crist created an Action Team on Energy and Climate Change in 2007. This group was tasked with investigating and recommending strategies for reducing GHG emissions, creating more sustainable energy systems in Florida, and for establishing Florida as an international leader in energy innovation. This group completed Phase 2 of their work and released a series of recommendations in mid-October. FESC is reviewing these recommendations to identify how FESC resources may assist in implementing these directions. Related to this, the Florida Legislature passed HB 697, which requires local governments to address energy systems and GHG emissions explicitly. For example, local comprehensive plans must establish a future land use vision that promotes energy sustainability and establish a set of transportation policies that promote GHG reductions and more efficient travel patterns. Specific elements of local comprehensive plans must take into account factors that affect energy conservation; energy efficiency in the design and construction of new housing and use of renewable energy resources; and "transportation strategies to address reduction in greenhouse gas emissions". In the State of Florida, the linkages between energy planning, environmental and economic sustainability, land use and transportation planning, and GHG reductions have never been stronger.

In this thrust FESC will examine the nexus of governance, business practices, and economic development. Florida must have a better understanding of the dynamic states of the sustainable energy economy. It must provide the right governance that leads to market pull for successful sustainable energy technologies to penetrate the Florida market. FESC will provide analysis to formulate state and local legislation designed to facilitate the location of renewable energy production facilities and other innovative or new energy infrastructure consistent with State policy while accounting for economic, social, environmental, and geographic variables.

Strategic Research Thrusts:
In addition to the overarching systems analysis thrust, FESC has identified six additional research thrusts to produce nationally competitive centers of research excellence leading to a positive impact on the State's economy.

1. **Enhancing Energy Efficiency and Conservation:** Energy efficient technologies have the greatest potential to reduce Florida's energy consumption. The focus is improving existing and new construction building efficiency and energy system integration for sustainable community developments, industry energy auditing and efficiency, outreach, and education. Buildings use more energy than any other sector of the economy, including transportation and industry, thus making it a major efficiency target. The integration of innovative energy-efficient technologies into our building operations and construction will result in cleaner, healthier, and more sustainable and economically viable communities that are less susceptible to disaster. As part of the Consortium, well-instrumented testing structures will be established to evaluate the effectiveness of integrated emerging technologies as well as hurricane-level wind resilience.

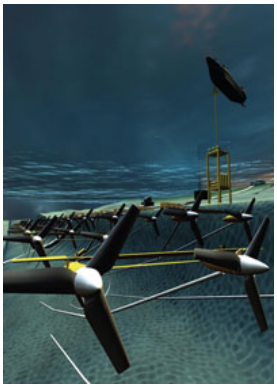
2. **Developing Florida's Biomass Resources**: Biomass offers tremendous opportunity as a major, near-term, carbon-neutral energy resource. Florida has more biomass resources than any other state, ~7% of the U.S. total. As such, harnessing these resources should be a key component of Florida's energy strategy. Efficient biomass conversion, however, is a complex system depending on locally available resources (due to high shipping costs of low energy density biomass). For example, South Florida is a major sugar cane and citrus producing region; whereas, North Florida has abundant woody biomass resources. Therefore, the most efficient technologies to harness these resources are regionally specific and demand a systems approach. Cellulosic ethanol and gasification processes are just entering the early commercial phase and offer many opportunities for improvement. These improvements are urgently needed to reduce capital cost and facilitate commercial deployment, thus creating new industry and new employment for Florida. The SUS is an internationally recognized contributor to biomass energy research and harnessing Florida's biomass energy resources is a critical component of the Consortium.

3. **Harnessing Florida's Solar Resources:** The direct conversion of incident solar radiation to electric power is the ultimate sustainable energy source. Not only does it bypass photosynthesis and thus carbon, but it can be implemented also in a distributed mode and fed to an existing distribution system (grid). Florida is one of the richest states in solar radiation, receiving ~6 kWhr/m^2/day. Therefore, an appropriate strategy for the Sunshine State is to include a significant solar component in its renewables package to offset growth in energy demand. This will be implemented in part by encouraging broad deployment of solar technologies and developing a Florida industry to meet the demand.

Fortunately, the solar expertise resident in the SUS is one of the largest in the country and will serve as a research and education base to attract industry. The implementation of this strategy will require continued cost reductions, and systems integration will be central. Collecting this broad research expertise through a consortium approach will facilitate the translation of solar innovations into more cost efficient systems.

4. **Ensuring Nuclear Energy & Carbon Constrained Technologies for Electric Power in Florida:** Nuclear energy provides large-scale, carbon-free electric power generation today and will remain a major contributor to our power needs. Florida's existing nuclear energy workforce at the five existing facilities will soon witness significant retirement. Additionally, an aggressive new plant strategy will require an expanded workforce. To meet these demands, an existing training reactor would be used to provide training in critical areas such as design, construction, operation, fuel reprocessing, and waste remediation. Development of clean coal and natural gas power generation with carbon sequestration is important for a carbon-constrained world since fossil fuels are the largest contributor to electric power generation. Advances in efficiency, demand response and management techniques, carbon capture and sequestration technologies and how these can be integrated into new fossil fuel generation plants are critical to meeting energy demand at an affordable cost. A particular focus of this thrust is exploring approached for *carbon sequestration technology relevant to Florida's geography*.

5. **Exploiting Florida's Ocean Energy Resources:** Covering 70% of the earth's surface, the oceans are a large solar collector. The resulting energy absorption creates thermal gradients and volatilizes water to produce a large potential renewable energy sources, including ocean current energy, wave energy, tidal energy, ocean thermal gradient energy and salinity gradient energy. For example, the Florida Current and Gulf Stream comprise fast and steady water flow in close proximity to a high population density. Although the flow is low velocity, its high density provides a high kinetic energy relative to wind, and it is estimated that multiple GW of power can easily be extracted using submerged turbines linked to in-shore areas where there is a demand for power. Florida Atlantic University's Center for Ocean Energy Technology provides a focus for development of renewable power sources.



6. **Securing our Energy Storage and Delivery Infrastructure**: Increased electricity demand and severe weather adversely impact the reliability and resilience of Florida's electric power infrastructure. Resulting power interruptions are an economic hardship of several $B/yr and a threat to public safety. This will escalate as Florida's population increases. The proposed diversified portfolio of distributed renewable generation will not become reality if electric infrastructure is not developed in conjunction with supply. Furthermore, the intermittent nature of some alternative power generation systems (e.g., solar) will require advanced storage solutions. Research possibilities include investigation of grid topologies, equipment and systems (e.g., power electronics, transformers, and substations), revenue metering, monitoring and control aimed at improved reliability, power quality, availability and resiliency of the transmission and distribution system.

Specific Research Programs:
FESC is in the process of implementing research projects consistent with the above strategic research thrusts. A short description of each program is given below.

Dedicated Energy Crop Development:
The first step in an integrated Bio-Energy industry is development of high yielding crops for conversion to renewable energy. The research aims to make breakthroughs in Florida energy crops and cultivars by using traditional and molecular genetic approaches. Energy crop research will focus on two groups, C-4 plants (e.g., cane and switch grass) and short rotation trees (e.g., pine and poplar). Natural cultivars will be screened for yield, and chemical compositions that enhance digestion and conversion into ethanol. Deliberate genetic changes will also be investigated to alter plant wall structure for more efficient extraction and depolymerization of carbohydrates. The proposed research will: advance our knowledge of how plants partition carbon; identify genes to accelerate breeding of plants that are more readily converted to fuel; establish best agricultural practices for production of Florida energy crops; and develop economic models to estimate costs and identify improvement opportunities.

Biochemical Conversion of Florida's Cellulosic Biomass to Liquid Fuels and Chemicals
This program focuses on the biochemical production of alcohols to serve as a bridge-fuel to reduce dependence on imported petroleum and decrease net carbon emissions using a non-food, biomass feedstock. This project will develop and demonstrate an integrated, multi-product biorefinery at pre-commercial scale to support a full economic and technical feasibility analysis for the use of Florida-grown feedstocks. The goal of this facility is to evaluate, validate, and improve processes, improve efficiency and decrease complexity, and accelerate full commercialization of cellulosic biorefineries in Florida. This facility represents a complete test bed for new trial crops as well as existing municipal, forestry, and agricultural residues. This facility will complete the renewable cycle by converting solar energy stored in biomass from Florida fields into automotive fuels and chemicals to replace petroleum. Together with energy crop production, this project will provide a comprehensive demonstration of a "Farm to Fuel"/"Fields to Wheels" biorefinery to facilitate commercial development of renewable fuels in Florida.

Integrated Biofuel, Hydrogen and Electricity Cogeneration from Biomass and Solid Waste

This research program addresses the incorporation of a biorefinery into existing agricultural, municipal and industrial activities that produce organic wastes or byproduct streams. Anaerobic digestion (ADG) and thermal gasification will be developed for wet and dry, respectively, biomass resources. ADG will be developed to produce CH_4-rich streams that will be tested directly in a Siemens 3kW solid oxide fuel (SOFC) for electric power generation as well as for a feedstock in subsequent bio-fuel synthesis. Thermal gasification processes will produce H_2 enriched synthesis gas. The resulting biogases will be analyzed for composition and utilized in a membrane reactor to produce pure H_2 and in subsequent catalysis to create clean burning liquid hydrocarbon fuels (from ethanol and gasoline to diesel and JP8 jet fuel). The membrane reactor produces pure H_2 from hydrocarbon feed stocks by internal steam reforming and water-gas shift reactions and the *in-situ* product removal drives H_2 production to higher yields than are otherwise thermodynamically achievable. This will demonstrate the efficacy, cost advantages of H_2 production from biomass, and advance the technology to the proof of concept scale for industry investment.

The fuels produced will be tested for combustion properties and electric power generation. SOFC operation on biogas would be the most efficient means of producing electricity from Florida's abundant renewable biomass resources. Siemens Power Generation (Orlando, FL) has identified biomass as a major part of its future growth. Optimization of the integrated system will be performed to adjust gasification design parameters based on projected overall economics of H_2, biofuel and electric power production. A system economic and GHG reduction analysis, including mass and energy balances to determine overall efficiencies, will be carried out using data obtained from the operation of the individual components and the integrated system. Economic feasibility of a full-scale system will be performed, including effect of increased capital investment and feedstock transportation costs.

Biofuel - Fuel Cell/Battery - Plug-in Hybrid Vehicle

A potential integrated sustainable transportation system is a plug-in hybrid electric vehicle (PHEV) charged by PV generated electricity while "plugged-in" and fuel cells operating on biofuel while in transit. Electric vehicles charged from solar PV are the ideal carbon free transportation. However, batteries do not currently give the desired driving range, so plug-in hybrids are the closest technology to achieving this dream of carbon-free transportation. A further dramatic improvement in efficiency and reduction in emissions would be achieved if the hybrid's IC-engine was replaced with a fuel cell. SOFCs are the most efficient technology for directly converting the chemical energy of hydrocarbon fuels to electricity on a "well to wheels" system-basis, thus, producing the least CO_2/kWh from conventional fuels and if designed to operate on biofuel would both be carbon-neutral and operating on a renewable resource. For a PHEV-SOFC/biofuel vehicle to be commercially viable its operation must be transparent (within existing transportation fueling infrastructure) and cost competitive with current technology. To achieve this we will integrate Li-Battery and SOFC developments. Energy storage is critical and research will be devoted to yielding higher voltage positive (olivine and spinel oxides) and negative (carbon nano-tube) electrodes that have potential for increased energy density and power. Research will further focus on fundamentals of ionic transport, phase stability at high charged state and the electrode/electrolyte interface, combining relevant experimental techniques with first

principles computational methods to identify factors that control Li mobility. Additional research will be aimed at anode and cell/stack development leading to demonstration of a complete low temperature biofuel SOFCs using the *FISE Energy Technology Incubator*. The will also develop and optimize operating control systems and evaluate life-cycle costs of the PHEV-SOFC/biofuel vehicle.

Solar Thermal Power for Bulk Power and Distributed Generation:

Solar thermal power is the most advanced and economic solar technology for bulk (MW scale) power production. At present about 5000MW of solar thermal power is in design or construction, including 300MW by FPL. The biggest advantage of solar thermal power over PV is that it can provide power for longer time by combining solar power during peak irradiance times and bio-fuel or thermal energy storage for off peak times. The present capital cost of solar thermal power plants is ~$3,500/kW which can be reduced to <$2,000/kW with experience, larger capacities, mass production and innovative research. The approach is to advance proven technologies for utility adoption while simultaneously developing new low cost and efficient technologies. We will develop test facilities and pilot demonstration systems, conduct technology evaluation and optimize plant operation strategies for Florida conditions. In addition, we will advance a novel thermodynamic cycle technology for combined power and cooling in cooperation with industry for commercialization. Successful effort on this project will result in increased renewable resource based power, reduction of GHG emissions, and establishment of a new power industry in Florida while helping the electrical utilities meet pending renewable portfolio standards. The project will be closely coordinated with FPL to support its planned 300MW solar thermal power plant. The project participants include recognized experts in Solar Thermal Power who have already developed the first generation design software for solar thermal power.

Si Photovolatics from Low-cost, Florida-derived Si Feedstock

The PV industry is the fastest growing industry in the world. The rapid expansion has produced a demand for Si feedstock than now exceeds the demand of the IC industry resulting in the need for nearly $10B in added capacity. This Si feedstock shortage has caused the contract price of PV grade Si to exceed $50/kg and recent spot market prices in the ~$300/kg range. SRI has developed a technology to take a Florida phosphate industry by-product to electronic grade Si at a cost well below PV industry targets. The goal of this Task is to establish a Florida-based PV industry using this Si feedstock. This *raw material to finished product PV industry* would be a major boon to the State economy, estimated to be a multi-billion dollar industry, similar in size to Florida's aerospace/defense industry. In addition, the number of indirect jobs created for a given investment in the PV industry (e.g., installation) is much greater than most industries. Further these jobs are high-value and there is tremendous export potential.

The largest US phosphate resources are in Polk County, FL, generating 32M tons of waste/year, and the resulting silicoflouride complexes (e.g., Na_2SiF_6) have little value. The SRI process converts Na_2SiF_6 to Si (product) and NaF (by-product used for toothpaste). Their process has been optimized to the extent that high purity, PV-grade silicon is produced and the estimated scaled production cost is ~$14/kg, well below the industry's target price. The process has been demonstrated to 2 MT/yr and is now ready for scale-up. The next step is vertical integration of the process to PV module production. Although SRI has promising preliminary results on the electrical properties of Si ingots as well as

fabricated cells, the influence of specific impurities on cell performance is not clear. This Task will direct research aimed at translation of this Si feedstock to high efficiency PV produced by this innovative process. We will generate performance data to guide SRI process improvement and assist qualification by potential PV producers. SRI will produce Si feedstock, cast ingots and characterize impurity content to verify initial quality. Wafers sliced from the ingots will be characterized for electronic properties (resistivity, carrier type, lifetime, and diffusion length). We will fabricate PV cells from these wafers, characterize performance (open circuit voltage, short circuit current, fill factor, and efficiency) and compare with results from conventional cells. Similar comparisons will be made for interested cell manufactures using their specific process.

Additionally, the Consortium team will develop novel approaches to thin-film-Si PV using the phosphate-based industry feedstock. Thin-film-Si is motivated by cost reduction by substituting the Si substrate with a less expensive material so that only a thin ~25 μm Si layer is needed. Cell performance will be evaluated and material properties characterized. The Consortia will serve as the interface between the feedstock provider (SRI) and the PV manufacturer by determining the relationship between feedstock quality and device performance.

Florida Based Low Cost Manufacture of Photovoltaic (PV) Systems

PV has been the fastest growing industry in the world for last 6 years. Furthermore, it is an industry that creates a significant number of high-skilled jobs. Although most of the current world-wide production is based on crystalline Si the next generation thin-film technologies are demonstrating cost advantages. Fortunately, the SUS has extensive research leadership in thin film technology (e.g. the world record 16% efficiency for CdTe was set by USF and held for 10 yrs).

To achieve the desired level of energy generation, efficiency has to be >13%, which has been achieved in the laboratory; however, there is an inability to transfer laboratory success into manufacturing success. The transfer process has been the purview of industry, with limited success. What is needed is a fundamental understanding of this process, which can best be done in a university environment with industry cooperation. In this program the combined SUS expertise in cooperation with local industry will build and operate a pilot line that includes all aspects of module fabrication and characterization for the SUS/industry partners to develop manufacturing processes.

Advanced PV Device Program

The US DOE Solar America Initiative (SAI) is the largest federal funding imitative in the U.S. UCF, UF and USF are already participating in the SAI program: UCF is conducting research with BP Solar on reliability and durability, UF is performing research on hybrid cells as well as CIGS ones, and USF is working on next generation CdTe cells. It is believed that the longer term generation cells will require an efficiency breakthrough (>25%) with low cost processing. Research will focus on hybrid organic PV, nano-architectures, multiple excitation generation, plasmonics, and tandem/multijunction cells. This exploratory research program is designed to position FESC to be more competitive for federal support. This program will leverage federal research dollars, create valuable intellectual property and hopefully attract major PV industries to the state.

PV Energy Conversion and System Integration

Considerable advances have been made in cell fabrication, but the systems optimization and integration has not kept pace. This research program explores an innovative system-driven approach for the design and commercialization of PV modules. The concept, termed *PlugN'Gen*, is a system architecture that allows PV modules to be produced and marketed just like other "plug and play" consumer products (e.g., TVs), overcoming the installation cost barrier. Today's grid-tied PV systems use PV panels in series to produce high-voltage DC. Centralized inverters convert this to grid-compatible AC. High-voltage DC is hazardous requiring expensive installation (installed cost is 2X that of the PV panels). In contrast, *PlugN'Gen* modules have inverters on the back of each panel. Installation of these modules is far less costly, requiring no special training. The modularity of AC module systems allows optimized harvesting of available power and systems to be incrementally installed (thus more budget-friendly). Advanced inverter topologies will be investigated to achieve efficiency, reliability, and cost objectives. Inverter lifetime will be increased to match the PV panels they service. Digital control techniques will allow integration of control functions, implementation of complex algorithms in low-cost controller chips, and better response to temperature and solar insolation changes.

Integrated PV/Storage and PV/Storage/Lighting Systems

Unfortunately, the timing for peak solar insolation does not coincide with peak power demand, thus energy storage (battery) is necessary, thus the need for an integrated/optimized PV/battery system. Another aspect of this is to consider a primary end use of electric power, lighting. Light emitting diodes (LED), operating on low voltage DC, have 4X the efficiency of incandescent bulbs. Each PV panel generates low voltage DC; however, PV power must be converted to 110VAC for grid-distribution and then stepped down to low voltage DC for LED lighting. Major system efficiencies can be attained by the PV/battery/LED system since each is a low-voltage DC device.

This research program aims to increase the efficiency and reduce the cost of solar power through the integration of PV, Li-battery, and LED lighting technologies. Since all components are in the form of thin films, the PV/battery/LED system can be integrated as a single module. Since half of the materials cost of each device is the substrate, integrated module will also reduce materials costs and processing steps. Importantly, their integration further eliminates the need for inverters since they are all low-voltage devices. Such an integrated device can be used to store energy during the day and power the LED panel for lighting in the evening. In addition, the possibility of fabricating a semi-transparent module will be explored. The success of this Task will lead to a novel solar-power lighting panel that can be used as a sky light during the day and a lighting panel during the night without using grid-power.

Solar and Biomass Fuels to Fuel Cell Emergency Power Backup

The goal of this program is to design, integrate, verify, and demonstrate both photovoltaic power, hydrogen generation through electrolysis to stored hydrogen fuel cell systems and stored liquid biomass fuel to fuel cell systems that will vastly improve the reliability and durability of backup power for extended outages. The uninterrupted power supply (UPS) for telecom applications represents a unique market entry opportunity for Florida. Current UPS systems are not satisfactory because of capacity loss in hot environments, and with 1000s of communications towers throughout Florida there is high commercial potential. Moreover, 20% of Florida telephone customers rely on UPS for emergency and personnel

communications after hurricane outages. Research will focus on the various components and systems demonstration to prototype development.

Energy Efficient Building Technologies and Zero Energy Homes

Buildings account for ~84% of total electric power use in the state, and thus represent a large source of potential energy savings for Florida. The US DOE goal is to create efficient "zero energy homes" using only on-site PV power. Energy storage can be provided by PHEVs. Using a systems approach to couple zero energy home technology with PHEVs offers the opportunity to develop marketable products that meet Florida's energy and environmental goals. New and emerging building energy efficiency systems require study with respect to Florida's unique hot/humid climate. Cost/benefit analysis of efficient buildings, building energy efficiency expertise in our education system and our marketplace along with creative financial instruments and business models are needed. To address this need this program will conduct field evaluations to document the cost/benefits of "beyond code" building energy efficiency programs; conduct testing of building efficiency options; create building energy course work; recruit advanced Florida builders and early adopter homeowners to collaborate on a zero energy home – PHEV design project; construct and monitor zero energy homes; develop optimization models, including benefit/cost analysis and grid interactions.

Establishing an Efficient and Reliable Energy Delivery Infrastructure

Most energy systems interact with the grid and by optimization can be integrated to reduce our overall energy demand and increase grid resilience. This program will use existing and planned communities as *in-situ* test beds to demonstrate integrated systems of revolutionary distributed green generation, improved grid and home efficiency, and automated energy conservation technologies for residential, substation, and distribution scale energy systems. Projected outcomes include: a 25% reduction in Florida's electric generation growth needs; reduced power system outages and restoration times for Florida; a market for green building construction, with distributed grid connected renewable generation; reduce GHG emissions; a new green energy value dimension to Florida's housing market, and ultimately Florida becoming a world leader in green community construction. The project will demonstrate advanced integrated energy generation, management, and utilization for substations, distribution, and modern residential and commercial developments, produce green distributed energy, reduce energy demand and improve security at the wide-area utility distribution level in Florida, and subsequently drastically reduce Florida's GHG emissions. Integration of three sub-systems: distribution level Renewable Energy Strategic Load Pockets; Intelligent Residential Energy Management Systems; and real-time transient analysis monitoring system will be included.

Carbon Capture and Sequestration

Current dependence on fossil fuels for electric power and transportation fuels continues to increase GHG emissions resulting in global warming and climatic change. Cost-effective CO_2 removal is required to accommodate growth and bridge our transition to greater energy diversity and efficiency. Several carbon sequestration approaches are under development by our team utilizing abundant Florida resources. Geological sequestration by CO_2 injection into saline carbonate aquifers is being developed and tested by USF. Biomass-based sequestration is being developed at UF using Florida crops and has widespread support of its agricultural industry. Chemical sequestration to useful products is being developed by

UCF via a novel catalytic process that includes solar-derived H_2. The resulting elemental carbon and lignin-based polymers can be stored and transported at ambient temperatures and pressures, and stored in geologic formations or used as possible commercial products. Each approach offers unique advantages to offset our transition to more carbon neutral power and transportation. Cost-effective carbon capture and sequestration is of primary interest to the major Florida power companies and FESC will play a coordination role. Florida agricultural industries are also very interested in developing carbon sequestration as a supplemental land use.

Clean Drinking Water using Advanced Solar Energy Technologies

Availability of fresh water is one of the largest problems facing the world and Florida is one of the most vulnerable to fresh water shortages. Moreover, Florida ground water is contaminated in many locations from leaky underground tanks, agricultural pesticides, and other chemicals. Although possible to desalinate abundant sea water, conventional systems are too energy intensive. Solar energy can provide the needed energy, and innovative new solar vacuum (USF) and humidification/dehumidification (UF) desalination systems can provide adequate fresh water for the state's needs. Systems will be developed for both bulk water desalination and small community needs/disaster response. We will also develop photocatalytic disinfection to remove contaminants and integrate these technologies with solar PV for complete water supply systems.

Ocean Energy Research

Florida Atlantic University (FAU) Center for Ocean Energy Technology has established leadership in harvesting the potential of ocean energy on a system-level. The program aims to continue this exploration and build on the capability, infrastructure, and expertise available in the SUS. The research team is working to have the test site recognized as a National Open-ocean Energy Laboratory for system-level test operation and data collection infrastructure. Areas of research include integrated system assessment to determine siting criteria, operating parameters for energy extraction prototype, migratory patterns and long-term effects on marine species, and risk reduction through developing testing protocols. Longer-term research is being conducted in the areas of software for system design and optimization, materials, composites, corrosion and anti-fouling, underwater power conditioning and transmission, and health monitoring including diagnostics and prognostics.

Industrial Partners Program Overview

A key component of FESC's creation is the broad industrial need for cutting edge energy R&D and education leading to high value technologies, innovations, and graduates. FESC is designing an Industrial Partnership and Innovation Strategy that assures active collaboration with the private sector and other partners who will support and guide FESC's vision, collaborate with FESC in our research, education, innovation, and outreach programs, and provide our students with an unparalleled educational experience to prepare them as R&D and innovation leaders of tomorrow. FESC's Industrial Partners Program (IPP) is being designed to be an effective and efficient avenue for industry to guide FESC activities and benefit from the research, education and outreach activities of the Consortium. As such, FESC's Industrial Partners Program mission is to establish partnerships with companies and other organizations that will play an important role in achieving FESC's goals and objectives. The program is being designed to promote a meaningful exchange between the partner universities and industrial partners from small, medium, and large companies, as well as other organizations such as incubators, research parks, investors, entrepreneurs, and government laboratories.

FESC Energy Industry Collaboration and Impact Programs

The FESC Industrial Partners Program will integrate with the Consortium's research, education, and outreach programs to assure that the Consortium's Industrial Partners are engaged in myriad ways to serve the State of Florida, the Consortium, the SUS universities, and Florida industry. As such, the IPP will engage with industrial practitioners, to include groups such as incubators and research park administrators, investors, entrepreneurs, etc. in a phased strategy that ultimately will leverage all of the assets of FESC and our contributing universities. Ultimately, FESC will establish programs to leverage the full range of university-industry collaboration avenues listed here. The FESC Industrial Collaboration program is being designed to phase in these various means to impact and grow Florida's energy industry over the next three years.

FESC Impacts to Florida Energy Industry

Leveraging Research Assets
- Technology licensing
- Industry sponsored research
- Joint research
- Facility usage agreements
- Technology donations

Leveraging Researcher Assets
- Industrial advisory boards
- Faculty sabbaticals
- Faculty consulting
- Visiting industry researchers

Leveraging Student Assets
- Proactive student recruitment
- Student internships and co-ops
- Student scholarships

Leveraging Educational Assets
- Publications
- Alumni Networks
- Distance education
- Lifelong learning
- Short courses, seminars

Industrial Partners Program Key Elements

Advisory Board (Consortium Model) - To drive active industrial collaboration from program inception through innovation and technology commercialization, FESC will organize an Advisory Board comprised of the Consortium's practitioners, technology end users, and development partners. In addition to Multi-national Corporations and Small and Medium Sized Enterprises, this board also comprises leading energy entrepreneurs, investors, technology incubator managers, and technology commercialization experts and companies that comprise the industrial partners of FESC. This Board will review Consortium research, education, outreach, industrial collaboration, and technology commercialization program progress and provide input to the FESC team on Consortium direction and overall strategy, primarily during the semi-annual FESC Advisory Board meetings.

One issue that has merited careful thought and attention is the best means to capture maximum value from industrial partners, including private sector financial support of FESC programs. Various models of structured IPP membership fees payable in the initial years of the Consortium have been explored and discarded by the FESC leadership team in lieu of a more open program of research and education collaboration and interaction as described below.

FESC will initiate an industrial collaboration program in which industry's contribution is garnered through financial support of energy related research, education, and outreach programs at each of the participating universities rather than through a centralized FESC Advisory Board Membership Fee. This model is optimal for FESC in its initial years as it is most inclusive of a broad range of entities that might support FESC's mission and allows the Consortium to demonstrate its impact to the state and private sector unhindered by contractual agreements which can take months of negotiations. This model involves the payment of a consortium membership fee through actions that promote FESC research or education programs such as sponsorship of one or more research projects, significant participation in collaborative research proposals to federal agencies, in-kind donations of equipment, technology, or human capital, support of educational or outreach programs, etc. The model provides high flexibility for FESC and companies to harvest value from myriad means of support, encourages the broadest support of FESC research, education and outreach programs, and provides a gate for companies currently working with FESC faculty to easily transition into the initial FESC Industrial Partners Program. The challenge of identification and quantification of specific means and levels of support at the member universities should be expected of industrial partners is currently being studied.

Executive Committee - The Advisory Board Executive Committee is currently being populated and will be comprised of select major energy industry players from large, small, and medium sized companies, incubator managers, investors, and government representatives that will guide the Consortium's research, education, innovation, and technology transfer activities and plans between meetings as appropriate. This group comprises a 10-15 member subset of the larger Advisory Board and will guide the FESC Leadership Team as a sounding board and communication means with Florida legislative and government leadership, private sector leaders, and key service provider leaders

(incubators, research parks, etc.). This group will be called upon as needed by the FESC leadership team during and between Advisory Board meetings to discuss specific opportunities and challenges that may arise throughout the course of FESC's lifetime. Operating protocols and bylaws for the Advisory Board and Executive Committee are being drafted and will be presented and discussed during the inaugural FESC Advisory Board meeting.

Performance Accountability / Advisory Board Meetings - Advisory Board members and others from industry will partner with FESC to guide our programs - from identifying future high-value energy research and education directions to speeding the transition of FESC research into innovation and bringing specific FESC technologies to commercialization. Performance accountability will be achieved via semi-annual Advisory Board meetings with substantial project review and discussion of the research, education, outreach, and technology commercialization programs. These meetings will typically span two days and be held in the Fall and Spring. During these meetings, FESC will engage industry, government, and service sector partners in reviewing the programs, engaging directly with students, reviewing posters, touring facilities, etc. Additionally, the Executive Committee of the Advisory Board will be provided an opportunity to discuss major initiatives and thoughts regarding FESC's progress and programs with the FESC leadership team and appropriate university administration. FESC's leadership may choose to rotate the meetings among the partnering universities in order to provide all Advisory Board members with a first hand look at the facilities that are being utilized and to be able to meet a greater proportion of the faculty and students participating in the program.

FESC Energy Summit - The annual Spring Advisory Board meeting will also be designed as an internationally recognized FESC Energy Summit wherein recognized experts from the public and private sectors in the various energy fields will be invited to provide major keynote addresses and briefings and the focus will be on high level accomplishments and advances of FESC and the field of energy research and development in general. The FESC Energy Summit will be geared to feature our research, education, outreach, and technology commercialization programs and latest results to our industry partners, but also to provide FESC with an international stage to feature the state of Florida's position as a global player in the field.

Incentives for Sponsored and Collaborative Research – FESC will work to encourage greater collaborative research in energy related fields among SUS university researchers as well as between FESC academic and Industrial Partner researchers. Several incentives will be explored and promoted as appropriate to drive greater research collaborations. For instance, FESC will seek to focus select Florida High Tech Corridor Council Matching Grants from each of UF, UCF, and USF toward collaborative energy research projects with central Florida companies. Additionally, FESC will explore the possibilities if replicating the Florida High Tech Corridor Council Matching Grants Research Program protocol to provide select matching funding to FESC researchers working with companies across Florida rather than geographically bounded to central Florida as with the Florida High Tech Corridor program. Also, FESC will attempt to negotiate with partnering universities a favorable overhead rate for Industrial Partners that sponsor new research with FESC faculty and

students and are willing to fund the research at the initiation of the project. Other incentives for greater collaborative research may include reduced fees for equipment use at partner universities and programs designed to encourage a focus on joint FESC / Industry collaborative research proposals to federal funding agencies on major energy grant programs.

Strong linkages to FESC education programs - The FESC Industrial Partners Program does not stand on its own in delivering maximum benefit to the State of Florida and Florida energy industries. The IPP will leverage the Consortium's education and outreach programs to provide distance education and training to Industrial Partners and other constituents through Webinars, short courses, seminars, etc. to be delivered through established distance education infrastructure at partner universities or newly established avenues through FESC. For instance, FESC will utilize the Advisory Board to design technical training programs in collaboration with community college partners, build energy expertise and infrastructure databases, produce an annual electronic student resume book, establish venues for targeted student recruitment by industry, etc..

Robust Technology Commercialization Program

A key component of the FESC Industrial Partners Program is an effective and efficient means to accelerate the Consortium's technology to market through firstly, our Industrial Partners (i.e. companies, entrepreneurs, investors, incubators, etc.), and secondly, other outlets (non-involved parties). In order to affect a robust technology management and commercialization program, FESC will work in concert with the offices of technology licensing/commercialization at our partner universities to assure that our programs support their mission of technology commercialization in general. Key to engagement of Industry Partners in a multi-university consortium such as FESC, is a clear and equitable technology management and commercialization process that appears seamless to our Industrial Partners. This will take working hand in glove with the partner university offices of technology licensing / commercialization so that FESC's technology management and commercialization processes are mutually agreeable to all participating universities and a large and diverse cadre of companies, entrepreneurs, etc. It is proposed that a modified NSF Engineering Research Center industrial collaboration and technology commercialization model as described below be utilized, providing a proven model upon which to build.

The FESC technology commercialization program is being designed to build on rather than replicate the technology licensing resources and protocols existing at each partner university (i.e. university intellectual property policies, invention disclosure and review protocols, patent/copyright protection and management resources, technology licensing, etc.). Following the best practices of the NSF Engineering Research Center technology commercialization model, FESC intends to supplement existing partner university technology commercialization / licensing programs with a technology management and commercialization protocol which will be discussed and agreed to between FESC and the partnering universities. Notionally, the FESC technology management program under consideration includes the following primary elements:

1. FESC will make available regularly scheduled intellectual property / technology management seminars and materials to FESC faculty and student researchers comprised of general information on university intellectual property management and specific information as to the protocols of FESC and the home university. Additionally, a technology commercialization seminar series may be provided through distance education / delivery infrastructure and can be focused on innovation and technology commercialization subjects of interest to students and faculty such as startup business planning, technology licensing and development, entrepreneurial fundraising, etc. Seminars will be designed and delivered in collaboration with the technology licensing / commercialization offices and centers for entrepreneurship at each of the participating universities.
2. FESC researchers will prepare invention disclosures, abstracts, pre-publications and posters for publication as per their standard university procedure. These materials will be submitted to FESC concurrent with submission for conferences and journals as well as Advisory Board or other FESC meetings. A window of early review may be provided by each home university for FESC Industrial Partners.
3. Materials will be catalogued and posted to the FESC Secure Web Site, which is accessible by password to Industry Partners. Industry Partners can review materials and identify potential patentable or copyrightable materials of interest. Other public materials may be posted to the non-secure area of FESC's web site.
4. FESC will work with the university licensing office(s) and Industry Partner to promote inventions/technology of interest for commercialization by Industry Partners or other interested parties.

FESC – Industrial Partner Agreements

As the Industrial Partners Program is fleshed out, it may become necessary to memorialize the relationship with FESC's industrial partners through a concise membership agreement. These relationships would be governed by FESC-wide membership agreements that will encompass all of the academic partners of the Consortium. These agreements will define the working and contractual relationships between FESC public and private sector partners and will be built from the foundation of the leadership team's previous experience in designing and implementing Engineering Research Center industrial partner membership agreements. Terms and conditions such as publication rights and confidentiality clauses will be designed in concert with our industrial partners with consideration given to the rights that will be necessary to entice members to fully engage in the Consortium's activities – especially in joint research projects.

Industrial Partner Benefits

A key to FESC's success in engaging with Florida's energy industry is a clear demonstration of value and benefits to our public and private sector partners. The following avenues to maximize benefits to our industrial partners are being explored:

Voting membership on the Advisory Board. During the semi-annual Consortium program reviews referenced above, the Advisory Board will be presented with the opportunity to

provide feedback to various research and education program components and, on occasion, may be invited by the FESC Director to vote on specific research, education, outreach, or technology commercialization programs for increased or decreased funding or attention. Advisory Board member votes will provide guidance to the FESC leadership team on program direction, but Advisory Board members will understand that final program decisions lie with the FESC leadership team regardless of the Advisory Board vote.

An opportunity to serve as an elected representative of the Executive Committee. It's envisioned that the FESC Advisory Board will engage a relatively large number of companies from across the state and nation to support and guide the consortium's activities and commercialize its technologies. While a breadth of industrial interactions is valued, it can also be cumbersome in providing focused guidance to the Consortium's leadership. As such, a smaller group, the Executive Committee will be selected from and elected by the Advisory Board to serve as their highest level of industrial guidance to FESC. This group will meet in special sessions with the FESC leadership team and university administrators during each semi-annual program review and dialogue as requested with the FESC leadership team between reviews.

A discounted overhead rate applied to additional energy research with FESC researchers. This benefit, if acceptable to the partner universities, can provide companies with a substantial incentive to increase their sponsored research support through FESC. The key is up-front payment for the sponsored project, which reduces the university's overhead burden. This model has been implemented successfully at the University of Florida where Particle Engineering Research Center Industrial Partners are granted a 25% overhead rate, vs. the standard 45% rate, for sponsored research with Center faculty.

Access to FESC Secure Information Network. FESC will build and implement a substantial web presence with which to communicate with Industry Partners and highlight the Consortium. FESC's web presence will include a password protected site providing FESC Industrial Partners with early access to invention disclosures, pre-publications, etc. per the discussion of technology commercialization above. The FESC non-secure site will also feature webinars and other materials that the consortium wishes to promote to a wider audience including policy makers, etc.

Other Benefits. FESC may provide other benefits to Industry Partners including priority in enrolling a representative, at reduced cost, in short courses, workshops, and conferences organized by FESC, priority access to R&D facilities and other instrumentation in FESC at a nominal fee to cover operation costs, on-location short courses for a reduced fee when possible, and a copy of all FESC reports & publications

EDUCATION AND OUTREACH

Florida's utilities have predicted that the State's energy use will significantly increase in the coming years. Also, workforce attrition in the energy and power sectors are anticipated to approach 40% by 2010. Finally, it is expected that some of the increased need for energy will be met by increases in energy efficiency and the use of renewable energy generation. These three factors have converged to demand a statewide level education program that will produce the workforce trained to meet Florida's energy needs. FESC is planning to address this need through the development of training and educational opportunities for multiple levels of the career ladder; community college trained technicians, bachelors level students, graduate researchers, and practitioners who seek an updating of their existing skills. This statewide initiative will be distributed across partner institutions and will capitalize on each institution's strengths to provide educational opportunities for both the conventional power generation industries and newly created energy related industries. New curricula in energy and coordinated programs across multiple universities will be developed to greatly expand the availability of energy education supporting existing and emerging energy industries in Florida. The program will also include components targeted to public and commercial sectors. For the commercial sector, the FESC Education Program will work closely with the Industrial Partners Program to ensure rapid dissemination of Center research results to this important constituent group.

The Florida Department of Education has implemented a "Greenforce Florida" initiative to help ensure that the State increases the number and skill level of workers that are available to meet the workforce needs of Florida's current and emerging alternative energy industries. The "Greenforce Florida" initiative's scope includes identifying gaps in current workforce education programs related to needed alternative energy occupations. A draft report was presented on December 8. Using these findings, we are working with this group, the community colleges and FESC universities to develop programs and related curricula to address gaps in current workforce education programs.

The **Community College** system is critical to this effort. Programming at the community college level will focus on both technician level 2 year students, as well as students planning on completing a Bachelors degree.

- FESC will work closely with the Florida Community College system as well as with the Florida Advanced Technological Education Center (FLATE), which coordinates the design and operation of industry specific training programs for technicians at the community colleges in Florida. FLATE is a National Science Foundation (NSF) funded Regional Center. FLATE's mission is to create a relevant statewide educational delivery system by supporting technical programs, curriculum development, best practices, student involvement, and outreach activities necessary to meet the workforce capacity and high performance skill needs of the manufacturing related sectors within the state. The goals of FLATE complement this component and FESC will disseminate energy curricula in cooperation with FLATE.

On the **Collegiate Level,** programming will include curriculum directed at the workforce for the nuclear industry, which now operates five nuclear power plants (FPL and PEF). To meet

the demand anticipated from retirement and expansion, a significant investment will be made to the UF training reactor. Other programs that FESC is planning to develop include:

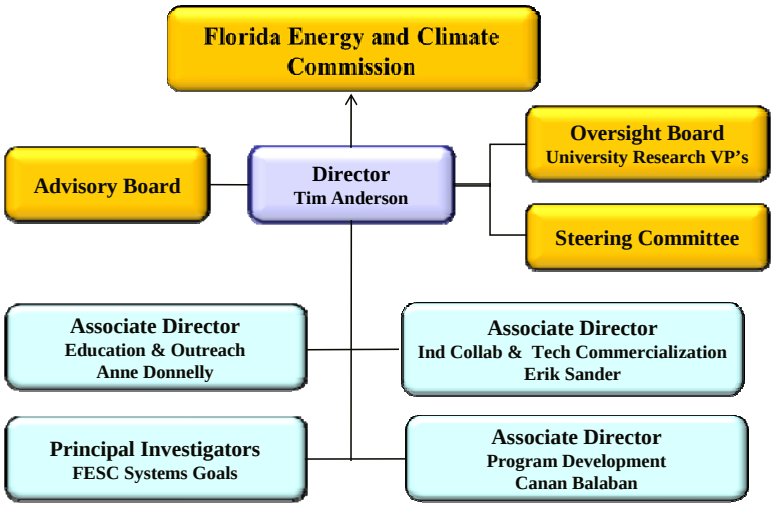
- A new M.S. degree program in Sustainable Energy and Power Engineering that will be distance delivered to make it available to the broadest of audiences.
- A video-conference seminar series to connect researchers and students across the Consortium
- An annual FESC research conference that will include a student poster session

Public Outreach: FESC is currently developing programs to leverage the existing network of extension offices to reach out to each of our communities. The Florida Cooperative Extension Service has experience developing and delivering educational programs and products related to energy- and resource-efficient community development with emphasis on housing. These programs and products include targeted continuing education courses for licensed builders, architects, engineers, landscape architects, interior designers, and others. Also, the UF Program for Resource Efficient Communities is an interdisciplinary group that promotes the adoption of best design, construction, and management practices in new residential master planned developments. FESC will work with these existing networks to provide programming on efficient use of energy and alternative energy generation methods to the general public as well as targeted to specific audiences such as builders, land planners, solar panel installers, and architects.

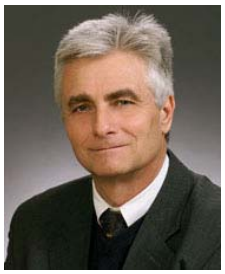
To meet these goals, FESC established an Education Committee that includes representatives from each institution who are involved in the education and outreach. This group will meet monthly to discuss program plans and implementation of the project. The initial charge to the committee is to develop an Education Strategic Plan that includes benchmarks and that distributes program responsibility across institutions. Dr. Anne Donnelly, UF, will serve as Associate Director for Education and Outreach. Committee members include Dr. Issa Batarseh, UCF, Dr. Richard Gilbert, USF, and Dr. Anjaneyulu Krothapalli, FSU. Dr. Pierce Jones, UF, will work on outreach through his experience with the Florida Cooperative Extension Service.

MANAGEMENT AND OVERSIGHT

FESC's leadership team and organizational structure assure that truly leading edge research and development of critical importance to the Florida and national economies are developed, world-class students in multiple disciplines of energy are trained, and industry reaps the full benefits of the Consortium's activities. The Leadership Team of FESC is comprised of highly experienced, highly successful innovators from the various energy related research fields, education, outreach, industrial collaboration, technology commercialization, and economic development. The FESC Director, Dr. Tim Anderson, is accountable for all mission activities of the Consortium and is assisted in his efforts by a Steering Committee, and Associate Directors in Industrial Collaboration & Commercialization, Education & Outreach, and Program Development. All of these key positions have been filled as outlined below. Brief biographies for all members of the Consortium leadership team are provided in Appendix A.



Dr. Tim Anderson; Director – The FESC Director overseas all activities of the Consortium and is responsible for strategy and direction as well as execution of the Consortium's operating plan - Dr. Tim Anderson has served the University of Florida College of Engineering for over 30 years in roles in increasing responsibility. Having progressed through the faculty ranks in the Department of Chemical Engineering, Dr. Anderson served as the UF College of Engineering Associate Dean for Research and Graduate Programs since 2003 and left that position to serve as the FESC Director. Dr. Anderson is a noted researcher and educator with 204 refereed journal publications and 301 conference presentations (35 invited) to his name. Dr. Anderson has been internationally recognized with many society and association honors and awards over the last five years, including the 2007 Warren K. Lewis Award for Chemical Engineering Education (AIChE) and the 2007 Professional Achievement Citation in Engineering (PACE) Award from Iowa State University. He is an Elected Fellow of the American Society for Engineering Education and the American Institute of Chemical Engineers. He was recently promoted to Distinguished Professor at UF.



Mr. Erik Sander; Associate Director of Industrial Collaboration & Commercialization - The

Associate Director oversees external partnerships and works to maximize impact on the Florida energy market. Mr. Erik Sander has served for over 10 years as an engineer in industry and is highly experienced in the field of technology transfer and commercialization of new technologies. He has founded several companies and also was a Principal two Florida-based early stage technology company investment funds. Erik has served as Director of the UF University Center, assisting small companies commercializing technology, and as the Associate Director for Industrial Collaboration and Technology Transfer for the Particle Engineering Research Center. He currently serves as the UF College of Engineering Director of Industry Programs.

Dr. Anne Donnelly; Associate Director of Education & Outreach – The Associate Director

coordinates activities in energy education, the preparation of an educated workforce, and outreach to both the public and private sectors. Dr. Anne Donnelly holds a B.A. in Biology, an MBA, and her PhD in Education. She has over 30 years of professional experience in the field of education as both a teacher and administrator including nine years as Associate Director for Education at PERC, where she has brought the program to national prominence. Dr. Donnelly currently serves as the Director of the South East Alliance for Graduate Education and the Professoriate (SEAGEP) which is a member of the National Science Foundation Alliance for Graduate Education and the Professoriate family of programs designed to increase diversity in the nation's professoriate in science, technology, engineering, and mathematics by providing students with exceptional Ph.D. experiences.

Ms. Canan Balaban; Associate Director of Program Development – The Associate Director

coordinates activities in program development, supports outreach activities, and assembles FESC reports. Ms. Canan Balaban holds a Masters degree in Chemical Engineering and has served for over 20 years in industry as a research scientist, engineer, and manager. Her industrial experience includes rechargeable batteries, bio-mass, coal desulfurization/gasification, sol-gel technology, and sintering. She has transferred a number of technologies from research to manufacturing and has two patents and one trademark. Ms. Balaban joined the University of Florida in 2003 and managed the $10M NASA funded Hydrogen Research Program until the end of the grant in March 2008. During this period she has worked with Dr. Eric Wachsman in the establishment of the Energy Technology Incubator - Center of Excellence. She currently serves as the Associate Director of Florida Institute for Sustainable Energy at the University of Florida.

Steering Committee – Per legislative mandate, the FESC Steering Committee comprises representatives of Florida Atlantic University, Florida International University, Florida State University, the University of Central Florida, the University of Florida, the University of South Florida, and the Florida Energy and Climate Commission. The Steering Committee is responsible for providing guidance on vision and direction to the FESC Director, facilitating

communication with each member university, recommending future FESC program directions and efforts, and conducting comprehensive performance evaluation and accountability measurement and assessment. To this end, the Steering Committee will work with the rest of the FESC leadership team to conduct assessments with regard to:

- *Research Effectiveness* - including grants and contracts applied/received, publications and presentations, and invention disclosures, patent activities, and licenses
- *Collaboration Effectiveness* – including inventorying collaborations with private sector and government labs, amongst SUS universities, with state government, K-12 programs, the community college system; as well as graduation and placement results
- *Economic Development Effectiveness* – including business start-ups, investments funds, job creation, and participant training

FESC has populated the members of the Steering Committee with energy research and education leaders from the partner universities, all of whose biographical sketches are provided in Appendix A:

- Dr. Issa Batarseh; Professor and Director, School of Electrical Engineering and Computer Science, University of Central Florida, Orlando, FL
- Dr. David Cartes; Interim Director, Institute for Energy Systems, Economics and Sustainability (IESES); Associate Director, Center for Advanced Power Systems; Associate Professor, Department of Mechanical Engineering; Florida State University, Tallahassee, FL
- Dr. Camille E. Coley; Assistant Vice President; Interim Director of Sponsored Research; Associate Director of the Center for Ocean Energy Technology; Florida Atlantic University, Boca Raton, FL
- Dr. D. Yogi Goswami; John and Naida Ramil Professor, College of Engineering, University of South Florida, Tampa, FL
- Dr. George Philippidis; Associate Director, Energy Applied Research Center, Florida International University, Miami, FL
- Dr. Eric Wachsman; Director, Florida Institute for Sustainable Energy; Director, UF-DOE High Temperature Electrochemistry Center; Rhines Chair Professor, Department of Materials Science and Engineering, University of Florida, Gainesville, FL

Oversight Board – The oversight board consists of the Vice President for Research or other appropriate representative appointed by the university president of each member of the Consortium. This board is responsible for the technical performance and financial management of the consortium and will be assembled on an as needed basis to perform its oversight function.

Advisory Board – The Advisory Board is comprised of the industrial and other partners of FESC and provides input to the Consortium Director on Consortium direction and overall strategy, primarily during the Consortium semi-annual Advisory Board meetings. The Advisory Board is also comprised of select energy industry players who support FESC's mission, leading entrepreneurs, venture capitalists, incubator managers, and technology commercialization organizations. Individual Board members will help to guide the Consortium's research, education, outreach, and technology commercialization activities between meetings as appropriate. The Advisory Board will also assist the Consortium Leadership in assuring the Consortium's activities are industrially relevant and are transferred to the private sector in a timely manner.

APPENDIX A – LEADERSHIP TEAM BIOGRAPHICAL SKETCHES

TIMOTHY J. ANDERSON
BIOGRAPHICAL SKETCH

Timothy J. Anderson: 300 Weil Hall, University of Florida, PO Box 116005, Gainesville, FL 32611, Phone (352) 392-0946, email: tim@ufl.edu

Fields of Interest: ***Discipline Research*:** Thin film photovoltaics; deposition of thin films; MOCVD and MBE of compound semiconductors, oxides, carbides & nitrides; thermochemistry and phase equilibria of inorganic materials; flow visualization; gas phase spectroscopy; wide bandgap materials. ***Engineering Education Research:*** Quantitative research methodologies, faculty development.

Professional Preparation:
Iowa State University, 1973, B.S. in Chemical Engineering
University of California, Berkeley, 1975, M.S. in Chemical Engineering
University of California, Berkeley, 1980, Ph.D. in Chemical Engineering

Research and Professional Experience
Director, Florida Energy Systems Consortium (2008-present)
Associate Dean for Research and Graduate Programs, University of Florida (2003-2008)
Chairman, Chemical Engineering Department, University of Florida, Gainesville, FL (1991-2003)
Distinguished Professor (2008), Professor (1988), Associate Professor (1983) and Assistant Professor (1978), Chemical Engineering Department, University of Florida
Visiting Professor, Laboratoire de Thermodynamique et Physico-Chimie Metallurgiques, Centre National de la Recherche Scientifique, Grenoble, France (1985-1986)

Selected Peer Reviewed Publications

Refereed Journal Publications: 204 *Conference Presentations:* 301 (35 invited)

1. "Comparison of Device Performance and Measured Transport Parameters in Widely-varying Cu(In, Ga) (Se, S) Solar Cells," I.L. Repins, B.J. Stanbery, D.L. Young, S.S. Li, W.K. Metzger, C.L. Perkins, W.N. Shafarman, M.E. Beck, L. Chen, V.K. Kapur, D. Tarrant, M.D. Gonzalez, D.G. Jensen, T.J. Anderson, X. Wang, L.L. Kerr, B. Keyes, S. Asher, A. Delahoy, and B. Von Roedern. *Prog. Photovoltaics*, 14(1): 25-43 (2006).
2. "Growth Mechanism of Catalyst- and Template-free Group III-nitride Nanorods," Y. S. Won, Y. S. Kim, O. Kryliouk, and T. J. Anderson. *J. Crystal Growth* **310**, 3735– 3740 (2008).
3. "Reaction Kinetics of $CuGaSe_2$ Formation from a GaSe/CuSe Bilayer Precursor Film," W. K. Kim, E. A. Payzant, S. Kim, S. A. Speakman, O. D. Crisalle, and T.J. Anderson. *J. Crystal Growth,* **310**, 2987–2994 (2008).
4. "Homogeneous Decomposition Mechanisms of Diethylzinc by Raman Spectroscopy and Quantum Chemical Calculations," Y. S. Kim, Y. S. Won, H. Hagelin-Weaver, N. Omenetto, and T.J. Anderson. *J. Phys. Chem. A*, **112** (18)**,** 4246-4253 (2008).
5. "*In situ* Investigation of the Selenization Kinetics of Cu–Ga Precursors Using Time-resolved High-temperature X-ray Diffraction," W.K. Kim, E.A. Payzant, T.J. Anderson, and O.D. Crisalle, *Thin Solid Films*, **515** (15), 5837-5842 (2007).
6. "Growth of InN Films and Nanorods by H-MOVPE." H. J. Park, O. Kryliouk, T. J. Anderson, D. Khokhlov, & T. Burbaev T, *Physica E: Low Dim. Sys. & Nanostructures*, **37**, 142-147 (2007).

7. *"In situ* Investigation of the Selenization Kinetics of Cu–Ga Precursors Using Time-resolved High-temperature X-ray Diffraction," W.K. Kim, E.A. Payzant, T.J. Anderson, and O.D. Crisalle, *Thin Solid Films*, 515 (15), 5837-5842 (2007).
8. "Investigation of Rapid Thermal Annealing on Cu(In,Ga)Se_2 Films and Solar Cells," X. Wang, S.S. Li, W. K. Kim, S. Yoon, V. Craciun, J. M. Howard, S. Easwaran, O. Manasreh, O. D. Crisalle and T. J. Anderson. *Solar Energy Mat. & Solar Cells*, 90, 2855-2866 (2006).
9. "Thermodynamic Description of the Ternary Compounds in the Cu-In-Se System," J. Shen, W. K. Kim, S. Shang, M. Chu, C. Song, and T. J. Anderson. *Rare Metals*, 25(5), 481-488 (2006).
10. "*In situ* Investigation on Selenization Kinetics of Cu-In Precursor Using Time-resolved, High Temperature X-ray Diffraction," W. K. Kim, E. A. Payzant, S. Yoon, and T. J. Anderson. *J. Crystal Growth*, 294(2), 231-235 (2006).

Synergistic Activities:

Journal Editorial Activities:

- Editor, *Chemical Eng. Education*
- Editorial Adv. Board, *J. SMET Ed.*
- Associate Edito rJ. Phase Equilibria
- Consulting Editor, AIChE Journal

Education-related Activities:

- Director of the NSF SUCCEED Eng. Education Coalition – 1997-2003
- Conducted over 20 New Faculty Career Development workshops

Selected Recent Society Activities:

Institute of Electrical and Electronics Engineers (IEEE)

• Secretary, 4th World Conf. on Photovoltaic Energy Conversion, Waikoloa, HW (2006)

• Program Chair, 33rd Photovoltaics Specialist Conference, San Diego, CA (2008)

Council for Chemical Research

• Governing Board (1996-1999) • Grad. Ed. Action Network Leader (2000-present)

Awards Last 5 Years:

2007 Warren K. Lewis Award for Chemical Engineering Education (AIChE)
2007 Professional Achievement Citation in Engineering (PACE) Award, Iowa State University
2006 Elected Fellow of the American Society for Engineering Education (ASEE)
2005 Elected Fellow of the American Institute of Chemical Engineers (AIChE)
2005 ConocoPhillips Lectureship (39th): Oklahoma State University
2004 Benjamin J. Dasher Award FIE Conf. (with M. Ohland, G. Zhang, and B. Thorndyke)
2003 Recipient Vanderbilt University Tis Lihiri Lectureship
2003 George Lappin National Program Committee Service Award, AIChE

ERIK J. SANDER
BIOGRAPHICAL SKETCH

Erik J. Sander:
300 Weil Hall, University of Florida, PO Box 116550, Gainesville, FL 32611-6550, Phone (352) 392-6000, email: esander@ufl.edu

Fields of Interest:
University-Industry collaborations, Technology commercialization, Entrepreneurship, Economic development, Technology company formation and growth

Professional Preparation:
The University of Florida, 1984, B.S. in Mechanical Engineering
The University of Alabama in Huntsville, 1994, M.S. in Management of Technology

Appointments:
Associate Director, Florida Energy Systems Consortium (2008-present)
Associate Director, University of Florida Center for Nano-Bio Sensors (2006-present)
Director of Industry Programs, University of Florida College of Engineering, (2000 – present)
President, V2R Group, Inc., Orlando, FL (2005 – present)
Director of Business Development, Cenetec Ventures, L.L.C., Gainesville, FL (2001 – 2002)
Associate Director for Industrial Collaboration and Technology Transfer, University of Florida Engineering Research Center (1997 – 2004)
Director, University of Florida University Center (1995 – 1998)
Technology Transfer Officer, Lockheed Martin Manned Space Systems, Huntsville, AL (1994 – 1995)
Senior Engineer, Lockheed Martin Manned Space Systems, Huntsville, AL (1990 – 1994)
Systems Engineer, General Electric Aircraft Engines, Cincinnati, OH (1989 – 1990)
Senior Engineer, Lockheed Martin Manned Space Systems, Huntsville, AL (1987 – 1989)
Engineer, Pratt & Whitney Aircraft Engines, West Palm Beach, FL (1984 – 1987)

Synergistic Activities:
Florida Research Consortium (Executive Committee and Education Committee Chair)
Association of University Technology Managers (Distance Education Committee)
Florida High Tech Corridor, University of Florida Lead (2005-present)
Consortium for Entrepreneurship Education (Charter Board Member)
UF College of Business Center for Entrepreneurship and Innovation (Charter Board Member)
Tampa Bay Technology Forum (Director)
National Science Foundation Engineering Research Center ILO Consultant Team
Florida Technology Transfer Conference (Charter Conference Chair)
Tampa Bay Technology Forum (Director)
Gainesville Area Chamber of Commerce (Director and Executive Committee)
Gainesville Technology Enterprise Center (Charter Director and Charter Chair)

Five Relevant Publications and Presentations:
1. BioFlorida Annual Conference – Biotechnology Market Research - October 2008; Amelia Island, FL
2. The World Bank Annual Bank Conference on Development Economics 2008 - Higher Education and High-Tech Industry – A Global Perspective – June 2008; Cape Town, South Africa

3. Florida Engineering Leadership Institute - Florida's High Technology Impact; January 2008, Orlando, FL
4. National Science Foundation Engineering Research Center Annual Meeting – Research Centers Worldwide – A Global View – November 2007; Washington, DC.
5. Society of Research Administrators International Annual Conference 2007 – SBIR & STTR Programs: The Private Sector, Public Sector and University Trifecta (Conference Best Paper Finalist; SRA Honors Convocation) – October 2007; Nashville, TN

Five Other Significant Publications and Presentations:

1. Journal of Research Administration; SBIR (Small Business Innovation Research and STTR (Small Business Technology Transfer) Programs: The Private Sector, Public Sector and University Trifecta; Spring 2008 (Volume 39, No 1).
2. International Business Forum 5th Annual Investing in Tech Transfer and Early Stage Investing Conference – Cutting Edge University-Industry Research and Tech Transfer Collaboration Models – October 2007; Boston, MA
3. Florida Technology Transfer Conference 2007 – International University / Industry Research Center Best Practices (Session Chair) - May 2007; Boca Raton, FL
4. Southeast Alliance for Graduate Education and the Professorate Professional Speakers Series – Intellectual Property and Technology Transfer for University Researchers; December 2006; Gainesville, FL.
5. Commercialization of Micro and Nano Systems (COMS) Conference 2005 - Integrating Technology Transfer and Entrepreneurial Programs in University-Industry Collaborations; August 2005; Baden-Baden, Germany

ANNE E. DONNELLY
BIOGRAPHICAL SKETCH

Anne E. Donnelly:
Particle Engineering Research Center
205 Particle Science & Technology, PO Box 116135
University of Florida, Gainesville, FL 32611-6135
Phone: (352) 846-1194 Fax: (352) 846 –1196 E-mail: adonnelly@erc.ufl.edu

Professional Preparation:

Ohio Wesleyan University	Zoology	B.A., 1975
Georgia State University	Finance	M.B.A., 1982
University of Florida	Instruction and Curriculum	Ph.D., 1996

Appointments:

2005 – Present	Present Director, NSF Southeast Alliance for Graduate Education and the Professoriate, University of Florida
1997 – 2005	Associate Director for Education and Outreach, PERC, University of Florida
1996 – 1997	Education Coordinator, PERC, University of Florida
1995 – 1996	Undergraduate Pre-Intern Field Advisor, University of Florida
1994 – 1995	Graduate Teaching Assistant, University of Florida
1983 – 1987	Marine Science Educator, University of Georgia Marine Extension Center, Skidaway Island, GA
1982 – 1983	Science Teacher, Dekalb County School District, Atlanta, GA
1981 – 1982	Program Manager, The Georgia Conservancy, Atlanta, GA
1978 – 1981	Environmental Specialist, Department of Natural Resources, The State of Georgia, Atlanta, GA
1975 – 1978	Education Specialist, University of Georgia Marine Extension Center, Sapelo Island, GA

Research and Educational Funding:

Source:	National Science Foundation
Amount:	$6,879,599
Title:	The South East Alliance for Graduate Education and the Professoriate (SEAGEP)
Role:	PI
Source:	Department of Health and Human Services – NIH
Amount:	$1,199,594
Title:	Diagnosis and Therapy of Drug Chemical Toxicity
Role:	Co-PI

Publications:

1. Donnelly, Anne E., Invited Lecture. “How to Develop a Comprehensive Center Education Program,” Science Foundation of Ireland, First Center Director’s Meeting, Dublin, Ireland, March 26, 2004.
2. Donnelly, A.E. and E. Hodge, “How to Develop an Education Program Evaluation Plan,” a workshop presented at the *NSF Research Centers Educators Network Meeting,* Gainesville, Florida, March 4-6, 2004.
3. Donnelly, A.E., and K. Johanson, “Solids Handling Education – Part of a Comprehensive Program at the NSF Particle Engineering Research Center, University of Florida,” *4th*

International Conference for Conveying and Handling of Particulate Solids, Budapest, Hungary, May 27-30, 2003.

4. Donnelly, A.E., and D. Haase, "Education Program Evaluation," *NSF Centers Educators Network Meeting*, Santa Cruz, CA, October 24-27, 2002.
5. Heath Wintz, R. Swift, P. Kumar, E. Hodge, C.Y. Wu, A.E. Donnelly, P. Biswas, A. Allen, R. Rober and P. Chapman, "An Interactive Aerosol Program for Undergraduate Education," *American Association for Aerosol Research*, Charlotte, NC, October 7-11, 2002.

SynergisticActivities:

Co-PI and Director for the NSF Alliance for Graduate Education and the Professoriate Program.
Program Director for The Advanced Training in Technology: Particle Science Summer School in Winter, PERC.
Developed and currently manage the PERC Undergraduate Research Program.
PI – PERC NSF Research Experience for Undergraduates Program.
Program Director - PERC NSF International Research Experience for Undergraduates Program.
Conduct education program evaluation on the PERC education programs as well as other NSF funded CCLI grants.
Founding Member of the NSF Research Centers Educators Network (NRCEN) and Chair of 2004 NRCEN Annual Meeting.

Graduate & Postdoctoral Advisors:

John J. Koran (deceased) University of Florida

Thesis Advisor & Postgraduate-Scholar Sponsor:

None

CANAN BALABAN
BIOGRAPHICAL SKETCH

Canan Balaban:
309 Weil Hall PO Box 116550, Gainesville FL 32611-6300
Phone: 352-392-8049/1043 E-mail: cbalaban@ufl.edu

Professional Preparation:
B.Sc., Chemical Engineering, Middle East Technical University, Ankara Turkiye
M.Sc., Chemical Engineering, University of Washington, 1980, Seattle WA

Appointments:
Associate Director, Florida Institute for Sustainable Energy University of Florida, Gainesville FL, 2007 to Present. Florida Center of Excellence devoted to developing a broad array of sustainable energy technologies and resources. Integrating technology, economics and policy to address Florida and US future energy needs.

Manager, NASA Hydrogen Research Program, University of Florida, Gainesville FL, 2003 to April, 2008. Managed $10M NASA funded Hydrogen Research Grant. Responsibilities included overseeing the budget, providing progress reports to NASA, organizing NASA review meetings for project evaluation, visiting Kennedy Space Center and Glenn Research Center to present UF hydrogen research program, proposal development, web site development, leveraging the existing funding to find new funding opportunities, establishing interactions between the UF and sponsoring companies, working with the FL Department of Environmental Protection office to promote UF energy expertise, attending energy related conferences and establishing contacts.

Vice-President, Engineering & Cyber Solutions, Gainesville FL, 2001-2004. E&CS is a software development and consulting firm. One of the owners of the company. Responsibilities included software testing to insure that the customer interface is user friendly, development of manuals for the software packages, database development, business reports, and customer interface.

Technology Staff Engineer, Energizer Power Systems, Alachua, FL, 1991-2001. Designed and managed the installation of two test-bed facilities, $3M in total, performed computer simulations, developed new products, and improved existing products and processes. Transferred two technologies from research to manufacturing.

Senior Research Engineer, Geltech, Inc., in Alachua, FL., 1986-1991. Manager of Manufacturing and Engineering, Director of Quality Assurance and Engineering. Installed a $1.7-million test-bed facility. Transferred three technologies from research to manufacturing.

Staff Engineer at the Phenolic Resin Division, Reichhold Chemicals Inc., Mt Bethel, NJ. Senior. 1985-1986. Provided direction, guidance and support for all engineering functions at each plant site for seven division locations.

Process Engineer, Computer System Manager, Reichhold Chemicals Inc., Tacoma, WA.. 1980-1985. Automated the manufacturing process of pentachlorophenol.

Project Engineer, Turkish Coal Enterprises, Ankara Turkiye. 1976-1977. Design and implementation of smokeless fuel plant.

Patents, Trade Secrets:
1. *Pasted positive electrode and process for its production*, 8/20/02, US Patent #6,436,575
2. *Improved nickel slurry*, 8/24/99, Trade Secret # 32701
3. *Method of making sol-gel monoliths*, 12/31/91, US Patent #5,076,980

Honors:
Canan Balaban is a member of the Tau Beta Pi Engineering Honor Society.
While a team leader at Energizer Power Systems, Balaban received the firm's Excellence Award for Employee Involvement.

ISSA BATARSEH
BIOGRAPHICAL SKETCH

Issa Batarseh:
School of Electrical Engineering and Computer Science, University of Central Florida, Orlando, FL 32816-2450
Phone: (407) 823-0185, e-mail: batarseh@mail.ucf.edu

Fields of Interest:
Solar energy conversion, grid-tied PV systems, advanced power electronics control systems.

Professional Preparation:

University of Illinois, Chicago	Electrical Engineering	Ph.D.	1990
University of Illinois, Chicago	Electrical Engineering	M.S.	1985
University of Illinois, Chicago	Electrical and Computer System Engineering	B.S.	1983

Appointment:

2002 – Present	Professor and Director, School of Electrical Engineering and Computer Science, University of Central Florida, Orlando, FL
1996 – 2002	Associate Professor, Electrical Engineering and Computer Science, University of Central Florida, Orlando FL
1991 – 1996	Assistant Professor, Electrical Engineering and Computer Science, University of Central Florida
1990 – 1991	Postdoctoral Researcher, University of Illinois, Chicago, IL
1989 – 1990	Visiting Assistant Professor, Purdue University, Hammond, IN
1987 – 1988	Research Engineer, Zenith Electronics Co., Glenview, IL
1903 – 1989	Research and Teaching Assistant, Electrical Engineering and Computer Science Department, University of Illinois, Chicago IL

Research Focus:

Dr. Batarseh's research interest focuses on the development of high frequency power electronic energy conversion systems to improve power efficiency, reduce cost and improve performance. The research includes solar energy conversion (inverters), monitoring systems, design of high frequency dc-to-ac and dc-dc resonant converter topologies; power electronic circuits for distributed power systems applications. His has published more than 350 journal, conference papers, book and book chapters.

Through an NSF Research Equipment Grant in 1994, Dr. Batarseh established the Florida Power Electronics Center (FloridaPEC) in the Department of Electrical and Computer Engineering, which is now the School of Electrical Engineering and Computer Science at University of Central Florida. The objective of the FPEC work is to carry out research and development of power electronic circuits and systems. Current research projects are funded by NASA, NSF, Florida Power, DoE, DoD and local industry.

Summary of Funded Research:

Total research funds for Dr. Batarseh in *Florida*PEC has reached more than $10 million from funding agencies including: NSF, DoD, DoE, NASA, U.S. Air Force, U.S. Army, U.S. Navy, and many private sector partners such as Emerson, Intel, Texas Instruments, APECOR, Inc., Lockheed Martin and Allied Signals Co. Obtained ten NSF Grants including research equipment grant, unsolicited grants and workshops.

Graduate Students Supervised:

20 Ph.D., 27 MS Theses, 8 Honor Undergraduate Theses. Three M.S. thesis and five Ph.D. dissertations are currently in progress.

Patents:

Dr. Batarseh has fourteen U.S. Patents issued and four are pending in the area of energy conversion and power electronics.

Summary of Publications:

Over the last fifteen years, Dr. Batarseh published more than fifty journals and more than 200 conference papers in areas of power conversion, efficiency improvement, power factor correction, maximum power tracking, high power density dc-dc and dc-ac conversion circuits. Please see web site at <*FloridaPEE.engr.ucf.edu*> for more details.

Honors & Awards:

- Elected Fellow of IEEE for contribution in power electronics, November 2005.
- Elected Fellow of IEE, 2004.
- Received the IEEE Best Paper award by IEEE Power Electronics Society, 2006.
- Future Energy Challenge Award, 3rd Place. Given by Department of Energy. 1st Place: Texas A&M, 2nd Place Virginia Tech, 4th place Wisconsin-Madison.
- College Distinguished Researcher Award, College of Engineering, 2001.
- Distinguished Researcher Award, School of EECS, 2000.
- Outstanding Engineering Educator of the Year, IEEE-1998.
- Fulbright Scholar, 1997.
- Outstanding Engineering Educator of the Year, IEEE-1998.
- Teaching Incentive Program Award, 1994, 1998, 2000.
- Outstanding Faculty Advisor Award, College of Engineering, 1998.
- Outstanding IEEE Power Engineering Orlando Chapter, 1997.
- IEEE Outstanding Chapter Award, IEEE Orlando Section, 1995.
- Excellence in Undergraduate Teaching Award, College of Engineering, 1996.

Professional Service:

- Serving as Associate Editor for IEEE Trans. On Aerospace and electronic Systems, and IEEE Trans. On Circuits and Systems.
- NSF –*Panel Reviewer for* CAREER, IGERT, REU, SBIR, STTR, International Programs.

Book Author:

Power Electronic Circuits, John Wiley Publisher, *2003 (546 pages).*

Recent Related Significant Publications:

1. H. Al-Atrash, F. Tian, and I. Batarseh, “Tri-Modal Half-Bridge Converter Topology for Three-Port Interface,” IEEE Trans. Power Electron., vol. 22, no. 1, pp. 341-345, January 2007.
2. Chris Iannello and Issa Batarseh, “Small Signal and Transient Analysis of a Full-bridge, ZCS-PWM Using Averaging,” IEEE Transactions on Power Electronics, August 2003.
3. C. Iannello, S. Luo, I. Batarseh.,” Dynamic Modeling of the Full bridge ZCS PWM Converter” Aerospace and Electronic Systems, IEEE Transactions, Volume: 38 Issue: 2 , pp. 515-526, April 2002.
4. J. Abu-Qahouq and Issa Batarseh, “Unified Steady-state Analysis of Soft-switching DC-DC Converters,” IEEE Transactions on Power Electronics, Vol. 17, No. 5, pp. 684-692, September 2002.
5. J. Abu-Qahouq and Issa Batarseh, “Unified Steady-state Analysis of soft-switching DC-DC Converters,” IEEE Transactions on Power Electronics, Vol. 17, No. 5, pp. 684-692, September 2002.
6. H. Al-Atrash, and I. Batarseh, “Boost-Integrated Phase-Shift Full-Bridge Converters for Three-Port Interface,” Power Electronics Specialists Conference (PESC) 2007, June 2007
7. F. Tian, K. Mansfield, J. Elmes, I. Batarseh and K. Siri,“A Single-Staged High-Frequency Link Inverter Design with Reactive Energy Storage Network,” PESC 2007, June 2007.
8. W. Al-Hoor, H. Al-Atrash, J. Abu-Qahouq, and I. Batarseh, “DSP-Based Stable Control Loops Design for a Single Stage Inverter,” APEC 2006, March 2006.

9. F. Tian, H. Al-Atrash, R. Kersten, C. Scholl, K. Siri, and I. Batarseh, "A Single-Staged PV Array-Based High-Frequency Link Inverter Design with Grid Connection," IEEE Applied Power Electronics Conf. and Expo., 2006, pp.1451-1454.
10. H. Al-Atrash, M. Pepper, and I. Batarseh, "A Zero-Voltage Switching Three-Port Isolated Full-Bridge Converter," IEEE Intl. Telecommunications Energy Conf., 2006, pp. 411-418.

Funded Research Contracts – Current:

1. Phase II SBIR – Integrated Three-Port Converters for Compact and Efficient Power Management (PI)
   Sponsor: NASA (UCF Share: $220,000)
2. Split-Phase DC-AC Converter for Hybrid Vehicles (PI), Sponsor: John Deere Corporation, $30,000
3. Phase I SBIR – Low-Cost, High-Efficiency, High-Density, DC-DC Converter (PI)
   Sponsor: US Navy, $70,000 (UCF Share: $30,000)
4. Phase I SBIR – Integrated Three-Port Converters for Compact and Efficient Power Management (PI)
   Sponsor: NASA, $100,000 (UCF Share: $35,000)
5. Bidirectional DC-DC Converter for Hybrid Vehicles (PI)
   Sponsor: John Deere Corporation, $30,000
6. Compact, High-Power, High-Power, High-Voltage, Bidirectional DC-DC Converter (ID: 1044633) (PI)
   Sponsor: APECOR (Applied Power Electronics Corp.), $375,000
7. Dynamic Digital Power Techniques to Improve Efficiency and performance (ID: 1045325) (PI)
   Sponsor: Intel Corporation, $100,000.00
8. FHTC match to Petra Solar: Research and Development Activities on Grid-Tie Inverter (ID: 1046578) (CO-PI)
   Sponsor: UCF/I-4, $450,000.00
9. Hybrid Architecture for Efficient Distributed Generation (ID: 1045083) (PI)
   Sponsor: California Energy Commission, $89,935.00
10. International Research Experience for Students in Photovoltaic Based Power Electronics Conversion Systems (ID: 1044854) (PI), Sponsor: National Science Foundation, $138,355.00
11. Prototype of T8 Quick-Disconnect Ballast (ID: 1046804) (CO-PI), Sponsor: AUI Management, $20,000.00
12. Radiation-Hard Power System-on-Chip (SoC) for Space Applications (ID: 1044393) (CO-PI)
    Sponsor: UCF/Space Research Initiative, $160,000.00
13. Research and Development Activities on Grid-Tie Inverter (ID: 1046579) (CO-PI), Sponsor: Petra Solar, $900,000
14. RF: Batarseh Research Support (ID: 1046506) (PI), Sponsor: Various, $5,000
15. STTR Phase I: POWER GENERATING BACKPACK (ID: 1044719) (CO-PI), Sponsor: APECOR, $30,030
16. The 21st Century World Class Scholars Program (ID: 1045059) (PI), Sponsor: FL Board of Governors, $2,000,000

DAVID A. CARTES
BIOGRAPHICAL SKETCH

David A. Cartes:
2000 Levy Avenue, Suite 140, Florida State University, Tallahassee, Florida 32310
Phone (850)645-1184, Email: dave@ieses.fsu.edu

Professional Preparation:
Ph.D., Engineering Science, Dartmouth College, 2001.
B.E., Engineering Science, Dartmouth College, 2000.
M.S., Management Science, Troy State University, 1992.
B.S., Business and Economics, Excelsior College, 1986.

Appointments:
Director, FSU Institute for Energy Systems Economics and Sustainability, 2008-Present.
Associate Professor, Florida State University, 2008-Present
Associate Director, FSU Center for Advanced Power Systems, 2006-present.
Assistant Professor, Florida State University, 2001-2008.
Office of Naval Research Summer Faculty Fellow, July-August 2004.
Graduate Research Assistant, Dartmouth College, 1995-2001.
Commissioned Officer, Nuclear Power Engineer, United States Navy, 1975-1994.

Selected Peer Reviewed Publications

Refereed Journal Publications: 33 Conference Presentations: 73

1. L. Liu, W. Liu; D.A. Cartes, "Particle swarm optimization-based parameter identification applied to permanent magnet synchronous motors," Engineering Applications of Artificial Intelligence, v 21, n 7, Oct. 2008, p 1092-100.
2. L. Liu, W. Liu; D.A. Cartes, "Particle swarm optimization-based parameter identification applied to permanent magnet synchronous motors," Engineering Applications of Artificial Intelligence, v 21, n 7, October, 2008, p 1092-1100.
3. P.K. Kolavennu, S. Palanki, D.A. Cartes, J.C. Telotte, "Adaptive controller for tracking power profile in a fuel cell powered automobile," Journal of Process Control, v 18, n 6, July 2008, p 558-67.
4. L. Qian, D.A. Cartes, H. Li "An improved adaptive detection method for power quality improvement," IEEE Transactions on Industry Applications, v 44, n 2, March-April 2008, p 525-33.
5. S.K. Srivastava, D.A. Cartes, F. Maturana, F. Ferrese, M. Pekala, M. Zink, R. Meeker, D. Carnahan, R. Staron, D. Scheidt K. Huang, "A control system test bed for demonstration of distributed computational intelligence applied to reconfiguring heterogeneous systems," IEEE Instrumentation & Measurement Magazine, v 11, n 1, Feb. 2008, p 30-7.
6. L. Liu, D.A. Cartes, "Synchronisation based adaptive parameter identification for permanent magnet synchronous motors," IET Control Theory & Applications, v 1, n 4, July 2007, p 1015-22.
7. W. Liu, J. Sarangapani, G.K. Venayagamoorthy, L. Liu; D.C. Wunsch, M.L. Crow, D.A. Cartes, "Decentralized neural network-based excitation control of large-scale power systems," International Journal of Control, Automation, and Systems, v 5, n 5, Oct. 2007, p 526-38.
8. K. Huang, D.A. Cartes, S.K. Srivastava, "A multiagent-based algorithm for ring-structured shipboard power system reconfiguration," IEEE Transactions on Systems,

Man, and Cybernetics--Part C (Applications and Reviews), v 37, n 5, Sept. 2007, p 1016-21.
9. L. Liu, K.P. Logan, D.A. Cartes, S.K. Srivastava, “Fault detection, diagnostics, and prognostics: software agent solutions,” IEEE Transactions on Vehicular Technology, v 56, n 4, July 2007, p 1613-22.
10. K. Huang, S.K. Srivastava, D.A. Cartes, “Solving the information accumulation problem in mesh structured agent system,” IEEE Transactions on Power Systems, v 22, n 1, February, 2007, p 493-495.

Awards Last Five Years

2007 Senior Member of the IEEE.
2005 President’s Award, American Society of Naval Engineers.
2005 Certificate of Appreciation, American Society of Mechanical Engineers (ASME)
2004 Certificate of Appreciation, American Society of Mechanical Engineers (ASME)

Synergistic Activities

- Member Working Group IEEEE Standard 1547.3&4 - Standard for Interconnecting Distributed Resources with Electric Power Systems
- Control Sub-Committee Chair IEEE Standard 45- Recommended Practice for Electric Installations on Shipboard
- Chair IEEE PES Working Group “Multi Agent Systems”
- Member IEEE PES Task Force on 'Intelligent Control Systems'
- Chaired the 2005 American Society of Naval Engineers - All Electric Ship Reconfigurable and Survivable Systems Symposium.
- Program Director 2003 ASME-Tallahassee Town Hall Meeting, Florida’s Energy Needs and the Role of Technology in Satisfying Those Needs.
- Program Director 2002 ASME-Tallahassee Town Hall Meeting, The Important Engineering and Technology-Related Issues Facing the State of Florida in the Next 5 to 10 years.

Journal Editorial Activities

IEEE Trans. System, Man, and Cybernetics,
IEEE Tran. Control Systems Technology,
ASME Dynamic Systems and Control,
IEEE Tran. Power Electronics,
IEEE Tans. Robotics,
AIAA Journal,
Marine Technology Society Journal,
IEEE Trans. Industrial Electronics,
EURASIP Journal on Applied Signal Processing,

D. YOGI GOSWAMI
BIOGRAPHICAL SKETCH

D. Yogi Goswami, Ph.D., P.E.:
Clean Energy Research Center, University of South Florida, 4202 East Fowler Avenue, ENB118, Tampa, Fl 33620, Tampa FL

Phone: 813 974 8840, e-mail: goswami@eng.usf.edu

Professional Preparation:

Ph.D.	Mechanical Engineering, Auburn University, Auburn, Alabama, USA	1975
M.S.	Mechanical Engineering, Auburn University, Auburn, Alabama, USA	1971
B.S.	Mechanical Engineering, University of Delhi, Delhi, India	1969

Appointments:

9/05 - Present	John and Naida Ramil Professor, College of Engineering University of South Florida, Tampa, Florida
6/90 – 9/05	UF Research Foundation Professor and Director, Solar Energy & Energy Conversion Laboratory, Department of Mechanical Engineering, University of Florida, Gainesville, Florida
8/77 - 5/90	Mechanical Engineering Department, North Carolina A&T State University, Greensboro, North Carolina

Editorial Activities:

- Editor in Chief, *Solar Energy Journal*, International Solar Energy Society, 2002 - Present
- Editor in Chief, *Advances in Solar Energy,* American Solar Energy Society, 1998-Present
- Editorial Board, *Advances in Solar Energy*, American Solar Energy Society, 1994-1997.
- Associate Editor, *Journal of Solar Energy Engineering*, 1989-1994
- Editorial Advisory Board, *CRC Mechanical Engineering Handbook*, 1995-Present; Hong Kong Institution of Engineers Journal; Journal of Energy & Environment, Bangladesh.

Awards and Certificates (Total: 53)

- Farrington Daniels Award, International Solar Energy Society, 2007 (**Highest award of ISES**)
- Frank Kreith Energy Award, ASME, 2007 (**Highest energy award of ASME**)
- Charles Greely Abbott Award for Outstanding Scientific, Technical and Human Contributions to the Development and Implementation of Solar Energy (**Highest Award of the American Solar Energy Society**).
- John Yellott Award for Outstanding Contributions to the Field of Solar Energy, ASME Solar Energy Division, 1995 (**Highest Solar Energy Award from ASME**).
- Distinguished Lecturer, ASME, 2000-2003
- Fellow, ASME, ASES

Publications: Books (Total: 14 Books, 13 Book Chapters, 6 Conference Proceedings)

Goswami, D.Y. and Kreith, F., *Energy Conversion,* CRC Press, August 2007.

Kreith, F. and **Goswami, D.Y.,** *Handbook of Energy Efficiency and Renewable Energy,* CRC Press, May 2007.

Kreith, F. and **Goswami, D.Y.,** *Handbook of Energy Management and End Use efficiency***,** CRC Press, July 2007.

Kreith, F. and **Goswami, D.Y.,** *Mechanical Engineering Handbook,* CRC Press, 2004.

Goswami, D.Y., (Editor-in-Chief), *Advances in Solar Energy: An Annual Review of Research and Development*. Volume 16, American Solar Energy Society, Inc., August 2005.

Goswami, D.Y., Kreith, F. and Kreider, J., *Principles of Solar Engineering* (2nd Edition), Taylor and Francis Pub., January 2000. (*NOTE:* This is a textbook for Senior Undergraduate and Graduate Students, 694 pages.)
Goswami, D.Y., *Progress in Solar Engineering,* Hemisphere Pub., 1987.
Goswami, D.Y., *Alternative Energy in Agriculture,* Vols. I and II. CRC Press, October 1986. (*NOTE*: This is a reference book in two volumes, about 200 pp. each.)

Patents (Total: 7 issued, 5 pending, 4 licenses, over $100 million sales)
Goswami, D.Y., "Electrostatic Photocatalytic Air Disinfection," U.S. Pat. No. 5,993,738, Nov. 30, 1999 (22 Claims).
Goswami, D.Y., "Photocatalytic System for Indoor Air Quality," U.S. Pat. No. 5,933,702 Aug. 3, 1999 (92 Claims).
Goswami, D.Y., "Photocatalytic Air Disinfection," US Patent No. 5,835,840, November 10, 1998. (27 Claims).
Goswami, D.Y., C.K. Hsieh, C.K. Jotshi and J.F. Klausner, "Contact Resistance Regulated Storage Heater," US Patent No. 5,694,515, December 2, 1997 (18 Claims).
Goswami, D.Y., C.K. Hsieh, C.K. Jotshi and J.F. Klausner, "Phase Change Material Storage Heater," US Patent Serial No. 5,687,706, Nov. 18, 1997 (17 Claims).

Refereed Publications: (More than 200)

Mahishi, M.R., **Goswami, D.Y.** 2007 "An experimental study of hydrogen production by gasification of biomass in the presence of a CO_2 sorbent", International Journal of Hydrogen Energy, 32: 2803-2808.

Sadramelli, S.M., and **Goswami, D.Y.**, 2007, "Optimum operating conditions for a combined power and cooling thermodynamic cycle" *Applied Energy,* Elsevier Pub., 84, 254-265.

Mahishi, M.R., Sadrameli. S.M., Vijayaraghavan, S., **Goswami, D.Y.** (Accepted for publication) "A novel approach to enhance the hydrogen yield of biomass gasification using CO_2 sorbent", ASME Journal of Engineering for Gas Turbines and Power.

Vijayaraghavan, S.**,** and **Goswami, D. Y.,** 2006, "A Combined Power and Cooling Cycle Modified to Improve Resource Utilization Efficiency Using a Distillation Stage." *Energy: The International Journal*, Volume 31, Issues 8-9, Pages 1177-1196.

Martin, C., and **Goswami, D.Y.** 2006, "Effectiveness of Cooling Production with a Combined Power and Cooling Thermodynamic Cycle," *Journal of Applied Thermal Engineering*, Vol. 26, 5-6, 576-582.

Vohra, A., **Goswami, D.Y.,** Deshpande, D.A., Block, S.S., 2006, "Enhanced Photocatalytic Disinfection of Indoor Air," *Applied Catalysis B: Environmental*, Vol. 65, 57-65.

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Goel, N., and **Goswami, D. Y.,** 2005, "A Compact Falling Absorber," ASME *Journal of Heat Transfer*, vol. 127, pp. 957-965.

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Goel, N., and **Goswami, D. Y**., 2005, "Analysis of a Counter-Current Vapor Flow Absorber," *International Journal of Heat and Mass Transfer*, Vol. 48, No. 7, pp. 1283-1292.

Mirabel, S.T., Goel, N., and Ingley, H.A., Goswami, D.Y., **2004, "Utilization of Domestic Fuels for Hydrogen Production"** ***International Journal of Power and Energy Systems*****, Vol. 24, No. 3, pp. 239-245.**

Al-Kharabsheh, S., and **Goswami, D.Y.**, 2004, "Theoretical analysis of water desalination system using low grade solar heat," *Journal of Solar Energy Engineering*, vol. 126, No. 2, pp.774-780, 2004.

Goswami, D.Y., Vijayaraghavan, S., Lu, S., and Tamm, G., 2004, "New and Emerging Developments in Solar Energy," *Solar Energy Journal,* vol. 76:1-3, pp. 33-43.

Tamm, G., **Goswami, D.Y.,** Lu, S., and Hasan, A.A., 2004, "Theoretical and Experimental Investigation of an Ammonia-Water Power and Refrigeration Thermodynamic Cycle," 2004, *Solar Energy Journal,* vol. 76:1-3, pp. 217-228.

Al-Kharabsheh, S. and **Goswami, D.Y.,** 2003, "Analysis of an innovative water desalination system using low-grade solar heat," *Desalination*, pp. 323-332, Sept.

Vijayaraghavan, S., and **Goswami, D. Y.**, 2003, "On Evaluating Efficiency of a Combined Power and Cooling Cycle," *ASME Journal of Energy Resources Technology*, Vol. 125, No.3, pp. 221-227.

Funded Research:

Managed over 70 externally funded research projects in the fields of solar energy, energy conservation, heat transfer, fluid mechanics and environmental control, from state and federal agencies, and private corporations.

Leadership At The Highest Levels Of Professional Societies:

- *President,* International Solar Energy Society (ISES), 2004- 2005
- *Governor,* ASME International, 2003-2006
- *Senior Vice President*, ASME International, 2000-2003.
- *Vice-President,* International Solar Energy Society (ISES), 2001- 2003.
- *President*, International Association Solar Energy Education (IASEE), 2000-2002
- *Member*, *Board of Directors,* American Solar Energy Society (ASES), 1995-1997, 1998-2000.

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BIOGRAPHICAL SKETCH

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Fields of Interest: Biochemical and thermochemical conversion of biomass to biofuels and value-added chemicals, hydrogen production from biomass via gasification, genetic engineering for ethanol and photobiological hydrogen production, and biodiesel production from non-edible plants and algae.

Professional Preparation:
Aristotelian University of Thessaloniki, Greece, 1984, B.S. in Chemical Engineering
University of Minnesota, 1989, Ph.D. in Chemical Engineering
University of Denver, 1995, M.B.A.

Appointments:
Associate Director, Applied Research Center, FIU (2002-present)
Director, Bio/Chemical Development, Thermo Fibergen Inc., Bedford, MA (1996-2001)
R&D Leader, National Renewable Energy Laboratory (NREL), Golden, CO (1989-1996)

Synergistic Activities:
Director, Center for Energy Technology of the Americas, FIU (2005-present)
Co-Director, Energy Business Forum, FIU (2006-present)

Dissertation Advisor: Professor Wei-Shou Hu, University of Minnesota, Minneapolis, MN

10 Relevant Discipline Research Publications:

1. Philippidis, G.P. and Wyman, C.E. "Production of Alternative Fuels: Modeling of Cellulosic Biomass Conversion to Ethanol" in Recent Advances in Biotechnology, Kluwer Academic Publishers, The Netherlands, 405-411 (1992).
2. Philippidis, G.P., Smith, T.K., and Wyman, C.E. "Study of the Enzymatic Hydrolysis of Cellulose for Production of Fuel Ethanol by the Simultaneous Saccharification and Fermentation Process", Biotechnol. Bioeng. 41, 846-853 (1993).
3. Philippidis, G.P. “Evaluation of the Current Status in Cellulase Production Technology”, in Enzymatic Conversion of Biomass for Fuels Production, American Chemical Society, 566, 188-217 (1994).
4. Philippidis, G.P. and Smith, T.K. “Limiting Factors in the Simultaneous Saccharification and Fermentation Process for Conversion of Cellulosic Biomass to Fuel Ethanol”, Appl. Biochem. Biotechnol. 51/52, 117-124 (1995).
5. Philippidis, G.P. "Cellulase Production Technology", in Handbook on Bioethanol: Production and Utilization, Taylor & Francis, Washington DC, 253-285 (1996).
6. Torget, R., Hatzis, C., Hayward, T.K., Hsu, T., and Philippidis, G.P. (1996) “Optimization of Reverse-Flow, Two-Temperature, Dilute-Acid Pretreatment to Enhance Biomass Conversion to Ethanol”, Appl. Biochem. Biotechnol. 57/58 (1996).
7. Rivard, C.J., Engel, R.E., Smith, T.K., Nagle, N.J., Hatzis, C., and Philippidis, G.P. “Measurement of the Inhibitory Potential and Detoxification of Biomass Ptretreatment Hydrolyzate for Ethanol Production”, Appl. Biochem. Biotechnol. 57/58 (1996).
8. Hatzis, C., Riley, C., and Philippidis, G.P. “Detailed Material Balance and Ethanol Yield Calculations for the Biomass-to-Ethanol Conversion Process”, Appl. Biochem. Biotechnol. 57/58, 443-459 (1996).
9. Toon, S.T., Philippidis, G.P., Ho, N.W.Y., Chen, Z.D., Brainard, A., Lumpkin, R.E., and Riley, C.J. “Enhanced Cofermentation of Glucose and Xylose by Recombinant Saccharomyces Yeast Strains in Batch and Continuous Operating Modes”, Appl. Biochem. Biotechnol. 63-65, 243-255 (1997).
10. Philippidis, G.P. and Hatzis, C. “Biochemical Engineering Analysis of Critical Success Factors in the Biomass-to-Ethanol Technology”, Biotechnol. Progress 13, 222-231 (1997).

Relevant Patents:

1. US Patents 5,424,417, 5,503,996, and 5,705,369 "Prehydrolysis of lignocellulose" (1995, 1996, and 1998, respectively).
2. US Patent 5,777,086 “Method of Recovering Lignin from Pulp and Paper Sludge” (1998).
3. US Patent 5,876,505 “Method of Producing Glucose from Papermaking Sludge Using Concentrated or Dilute Acid Hydrolysis” (1999).
4. US Patent 5,919,424 “Method of Recovering Minerals from Papermaking Sludge and Sludge-Derived Ash” (1999).
5. US Patent 5,961,941 “Production of Precipitated Calcium Carbonate from Papermaking Sludge and Sludge-Derived Ash” (1999).
6. US Patent 6,156,226 “Liquid and Solid De-Icing and Anti-Icing Compositions and Methods for Making Same” (2000).
7. US Patent 6,758,996 “Cellulose-Reinforced Thermoplastic Composite and Methods of Making Same” (2004).

Selected Publications: Recent invited/editorial articles

1. Philippidis, G. “Energy Security Achievable with Biofuels Made in the Americas”, Ethanol Producer Magazine, Vol. 14, Issue 8, 232-235 (2008).
2. Philippidis, G. (with McFarlane R.) “How Free Trade Can Help Solve the Energy Crisis”, Wall Street Journal, July 26-27, p. A9 (2008).
3. Philippidis, G (with Modesto Maidique) “Diversifying Our Energy Is Imminent Security Concern”, The Miami Herald, October 26, p. 1L-2L (2008).

Synergistic Activities:

Conducted over 12 workshops in the past 2 years on the expert subjects of Energy Security, Biofuels and Biomass, New Vehicle Technologies, Energy Outlook, and Renewable Energy Deployment.

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Eric Wachsman:
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Professional Preparation:
Ph.D. Materials Science & Engineering, Stanford University, 1990
M.S. Chemical Engineering, Stanford University, 1986
B.S. Chemical Engineering, University of California at Berkeley, 1982

Appointments:
***Director**, Florida Institute for Sustainable Energy, University of Florida, Gainesville, FL, 2006-present* - Florida Center of Excellence devoted to developing a broad array of sustainable energy technologies and resources, from fuel cells and hydrogen production to photovoltaics and biomass. Integrating technology, economics and policy to address Florida and US future energy needs.

***Director**, UF-DOE High Temperature Electrochemistry Center, University of Florida, Gainesville, FL, 2005-2008* - US Department of Energy (Fossil) research center focused on fundamental investigations of transport in, and heterogeneous reactions on the surface of, ion conducting ceramics. Research spans from first principle calculations to development of materials and material microstructures for high temperature electrochemical energy devices.

***Rhines Chair Professor**, Department of Materials Science and Engineering, University of Florida, Gainesville, FL, 1997-present* - Electronically and chemically functional materials. Research is focused on solid ionic-conductors and electrocatalysts, and includes the development of solid state fuel cells, batteries, sensors, and gas separation membranes, and the elucidation of both transport mechanisms (through structural analysis, defect equilibria, and computer modeling) and electrocatalytic mechanisms (by combined catalytic and electrochemical analytical techniques). Teaching includes courses in solid state ionics and the electronic properties of ceramics.

***Senior Scientist**, Materials Research Center, SRI International, Menlo Park, CA, 1989-1997* - Principal investigator for projects on the development of moderate temperature solid oxide fuel cells (SOFC), solid state gas sensors, and the electrocatalytic reduction of NO_x, using a solid oxide electrochemical cell. Led a group in the synthesis and fabrication of functional ceramic materials and devices, characterization (physical, thermochemical, and electrochemical) of metal oxide electrocatalysts and kinetic evaluation employing such analytical techniques as temperature programmed desorption and reaction (TPD & TPR).

***Lecturer**, Department of Materials Science & Engineering, Stanford University, Stanford, CA, 1993* - Graduate and undergraduate courses in Materials Thermodynamics.

***Member Research Staff**, Xerox Palo Alto Research Center, Palo Alto, CA, 1984-1986* - Developed and transferred large-area □-Si processing technology from Fuji-Xerox (Japan) and set up pilot-line facility at Xerox. Received Achievement Award for fabricating first large-area integrated circuits.

***Process Engineer**, Non Volatile Memory Division, Intel, Santa Clara, CA, 1982-1984.*

Selected Peer Reviewed Publications (Total: 123)

1. "Isotopically Labeled Oxygen Studies of the NO_x Exchange Behavior of La_2CuO_4 to Determine Potentiometric Sensor Response Mechanism," F. M. Van Asshe and E. D. Wachsman, *Solid State Ionics*, accepted.
2. "Investigating Oxygen Surface Exchange Kinetics of $La_{0.8}Sr_{0.2}MnO_3$ and $La_{0.6}Sr_{0.4}Co_{0.2}Fe_{0.8}O_3$ Using an Isotopic Tracer," C. C. Kan, H. H. Kan, F. M. Van Assche, E. N. Armstrong and E. D. Wachsman, *Journal of the Electrochemical Society*, **155**, B985-B993 (2008).
3. "Infrared and X-ray Photoemission Spectroscopy of Adsorbates on La_2CuO_4 to Determine Potentiometric NO_x Sensor Response Mechanism," F. M. Van Assche, J. C. Nino and E. D. Wachsman, *Journal of the Electrochemical Society*, **155**, J198-J204 (2008).
4. "Vacancy Ordered Structure of Cubic Bismuth Oxide from Simulation and Crystallographic Analysis," D. S. Aidhy, J. C. Nino, S. B. Sinnott, E. D. Wachsman, and S. R. Phillpot, *Journal of the American Ceramic Society*, **91**, 2349-2356 (2008).
5. "High Performance Composite $Bi_2Ru_2O_7$ - $Bi_{1.6}Er_{0.4}O_3$ Cathodes for Intermediate Temperature Solid Oxide Fuel Cells," M. Camaratta and E.D. Wachsman, *Journal of the Electrochemical Society*, 155, B135-142 (2008).
6. "Influence of Adsorption and Catalytic Reaction on Sensing Properties of a Potentiometric La_2CuO_4/YSZ/Pt Sensor," J. Yoo, S. Chatterjee, F. M. Van Assche, and E. D. Wachsman, *Journal of the Electrochemical Society*, **154**, J190 (2007).
7. "Higher Ionic Conductive Ceria Based Electrolytes for SOFCs," S. Omar, E. D. Wachsman, and J. C. Nino, *Applied Physics Letters*, **91**, 1444106 (2007).
8. "The Role of Point Defects in the Physical Properties of Nonstoichiometric Ceria," K. Duncan, Y. Wang, S.R. Bishop, F. Ebrahimi, and E. D. Wachsman, *Journal of Applied Physics*, **101**, 044906 (2007).
9. "Three-Dimensional Reconstruction of Porous LSCF Cathodes," D. Gostovic, J.R. Smith, K.S. Jones and E.D. Wachsman, *Electrochemical and Solid State Letters*, **10**, B214-217 (2007).
10. "Schottky Barrier Formed by Network of Screw Dislocations in $SrTiO_3$," X. Guo, Z. Zhang, W. Sigle, E. D. Wachsman, and R. Waser, *Applied Physics Letters*, **87**, 162105 (2005).

Synergistic Activities

Fellow of the Electrochemical Society
University of Florida Research Foundation Professor, 2005-2008
Editor, *Ionics*
Associate Editor, *Journal of the American Ceramic Society*, 1997-2005
Chair, High Temperature Materials Division of the Electrochemical Society, 2006-2007
Board of Directors, The Electrochemical Society, 2006-2007
Fuel Cell Organizing Committee, The Electrochemical Society
Councilor, Florida Section of the American Ceramic Society