INTRODUCTION

During their senior year, UCF engineering students bridge the gap between academic and professional experience by participating in year-long design and build projects that involve different disciplines of the engineering profession and include multidisciplinary teams. Along with their faculty advisors, engineering students work to develop innovative product proposals that incorporate appropriate engineering standards and multiple realistic constraints, conduct the design analysis, design and build a prototype, and prepare engineering reports. At the end of their senior year, the students present and demonstrate their projects in a day long Senior Design Symposium open to the campus community and industry. This year, the symposium was held on Friday, April 8, 2011 and focused on the theme of renewable and sustainable energy. For the third year in a row, the symposium was sponsored by Progress Energy. Twenty seven projects were presented to more than 325 attendees.

Besides showcasing engineering innovation and talent development for the next wave of UCF engineers, the projects included invaluable experience in applying knowledge and skills acquired in earlier coursework, and in project management, entrepreneurship, leadership, social responsibility, and team building. Applying classroom learning for the solution of real-world problems is a commitment we have made to our students. This year’s symposium was a great example of innovation and experience-based learning at its best.

A sincere thank you goes to the symposium sponsor Progress Energy and symposium keynote speaker Vincent Dolan. Mr. Dolan, President and CEO of Progress Energy Florida, personally reviewed each of the projects. “I’m impressed by the richness and diversity of the projects exhibited at this symposium,” he said. “The way we produce and generate power 10, 20, 30 years from now will be largely driven by the innovation, determination, and strategic vision of today’s bright young minds such as these students”.

I also want to acknowledge the support we received from Orange County Mayor Teresa Jacobs, UCF’s Department of Sustainability & Energy, Harris Corporation, and Envirobrite, among others who were partner contributors to the 3rd Annual Symposium. Finally, special thanks to Mr. Robert Rich, director of corporate relations for facilitating this symposium which provided our students a venue for showcasing their senior design projects, and for preparing this symposium report.

We welcome the opportunity to invite individuals, organizations and companies to support and sponsor future senior design projects benefitting the education of our students and providing them with important skills that they will need throughout their professional careers.

Marwan A. Simaan, PhD, PE
Dean, College of Engineering & Computer Science
University of Central Florida
# TABLE OF CONTENTS

DEPARTMENT OF MECHANICAL, MATERIAL & AEROSPACE ENGINEERING .................... 6

Senior Design Projects of MMAE .............................................................................. 6

Ablative Rocket Nozzle ......................................................................................... 7

Abandoned Oil Well Monitoring System .............................................................. 9

ASHRAE - HVAC System Selection ...................................................................... 11

ASHRAE - HVAC System Design .......................................................................... 14

Bi-Directional Hydro-Turbine .................................................................................. 16

Environmental Wind Tunnel .................................................................................... 17

Fuel Cell in an Unmanned Aerial Vehicle .............................................................. 19

Hybrid Go-Kart with Super Capacitor Boost ......................................................... 22

Hydraulic Regenerative Braking ............................................................................. 24

Ocean Buoy for Wave Power Generation .............................................................. 26

Organic Rankine Cycle ........................................................................................... 27

Solar Balloon System ............................................................................................. 29

Solar Module (Photovoltaic Array) Mounting System ........................................... 31

Solar Powered Car Cooler ..................................................................................... 33

Solar Trough for Hot Water .................................................................................... 35
DEPARTMENT OF ELECTRICAL ENGINEERING and COMPUTER SCIENCE ............................... 38
Senior Design Projects of EECS ............................................................................................................. 38
Economy Mode Control Unit .................................................................................................................. 39
Intelligent Electric Vehicle Driving System ........................................................................................... 41
Home Energy Management System ........................................................................................................ 43
Low Concentration Thin Films with Solar Tracking .............................................................................. 45
Oil Well Monitoring System ................................................................................................................... 47
Parking Garage Management System ..................................................................................................... 49
Solar Golf Cart ........................................................................................................................................ 51
Solar Powered Tracker ............................................................................................................................ 54
UCF Solar Farm ...................................................................................................................................... 55

DEPARTMENT OF INDUSTRIAL ENGINEERING & MANAGEMENT SYSTEMS ....................... 58
Senior Design Projects of EECS ............................................................................................................. 58
UCF Solar Farm ...................................................................................................................................... 59
DEPARTMENT OF MECHANICAL, MATERIAL & AEROSPACE ENGINEERING

We provide our students opportunities to engage in experiments, design work, project work, industrial training and team work to enhance the learning process so vital in engineering education. In addition, our students can engage in research early on in their careers working with our outstanding faculty to gain a deeper level of expertise in a selected set of subjects chosen from tracks in mechanical systems, energy systems, aerospace systems, or advanced materials. These undergraduate research experiences are a natural stepping stone for extension of knowledge and the development of new techniques and ideas for graduate work. Our students have won highly competitive graduate research fellowships offered by federal agencies such as the National Science Foundation, Department of Defense, and NASA to pursue graduate work leading to Ph.D.’s at an institution of their choosing - including the opportunity to continue their graduate work here at UCF.

Senior Design Projects of MMAE

Abandoned Oil Well Monitoring System
Ablative Rocket Nozzle
ASHRAE - HVAC System Design
ASHRAE - HVAC System Selection
Bi-Directional Hydro-Turbine
Environmental Wind Tunnel
Hybrid Go-Kart with Super Capacitor Boost
Hydraulic Regenerative Braking
Ocean Buoy for Wave Power Generation
Organic Rankine Cycle
Solar Balloon System
Solar Module (Photovoltaic Array) Mounting System
Solar Powered Car Cooler
Solar Stirling Engine
Solar Trough for Hot Water
Utilization of a Proton Exchange Membrane Fuel Cell in an Unmanned Aerial Vehicle
Ablative Rocket Nozzle

DEPARTMENT OF MECHANICAL, MATERIAL & AEROSPACE ENGINEERING

Charles Biset
Jack Bower
Juilz Cespedes
Kyle Flynn

Dr. Jan Gou – Faculty Advisor

Sponsored by Progress Energy

Purpose
To test newly researched materials under challenging conditions in order to obtain thermal and aerodynamic properties.

Applications
Extreme Condition Turbine Blades
As used by companies such as Siemens, General Electric, Boeing, etc.

Manufacturing & Testing
Testing Conditions
- Supersonic Velocity
  Mach 1-2
- High Pressure
  ~1000 psi
- High Temperature
  ≥1500 °C

Manufacturing

High pressure injection molding system

Temperature
Thermocouples
Thermal couples

Pressure

Thrust

Erosion

Charles Biset, Jack Bower, Julz Cespedes, Kyle Flynn
Ablative Rocket Nozzle

Research into the material properties of nanoparticles is ongoing because of the changes exhibited in these properties with the decrease of the surface area of the individual particles. The objective of this project is to design an ablative rocket nozzle and test system to obtain thermal and aerodynamic material properties of the nanoparticles implemented in carbon fiber and phenolic resin mixture.

The decision for the usage of carbon phenolic as the ablative material was determined through problem definition parameters established by ourselves and the customer. The carbon phenolic was most successful at meeting the weight requirements. Nozzle angles and lengths defined as design variables determined the most aerodynamic shape of the nozzle.

The optimal nozzle parameters designed were for a 12° angle of divergence with a length of 3.94 in and exit diameter of 2.25 in. Fluid analyses through SolidWorks Flow-Xpress confirmed velocity requirements and absences of shock waves in the nozzle. Research into the construction of an ablative rocket nozzle to meet the design parameters set by this investigation for testing purposes was halted due to unforeseen factors of the phenolic resin material.

The test system designed by this investigation to obtain thermal and aerodynamic properties was the Propulsion Unit Static Test Restraint System. The test system utilizes three data collection systems, a load cell for thrust data, a pressure transducer for chamber pressure data, and two thermocouples placed on the edge of the rocket nozzle and above the test restraint tube to obtain temperatures. The testing of the rocket nozzles requires the use of a 54 millimeter propulsion unit, including motor casing, Ammonium Perchlorate Composite Propellant reloads, forward closure, graphite rocket nozzle and assorted o-rings and snap rings. The graphite nozzle was used to verify the Propulsion Unit Static Test Restraint System's ability to collect appropriate data for the test firing.

The results of the static test fire conducted Propulsion Unit Static Test Restraint System proved that the data acquisition programming and electronic components were successful. Pressure recordings were not obtained due to accidental damage caused to the mating connector of the pressure transducer to the copper tubing. Thrust and temperature measurements were obtained with the graphite nozzle in place. The maximum thrust obtained was 1293.6 N 5.3 seconds after ignition and the maximum temperature recorded was 1450 °C for the plume 5.7 seconds after ignition.
Abandoned Oil Well Monitoring System

DEPARTMENT OF MECHANICAL, MATERIAL & AEROSPACE ENGINEERING

Joe Turchiano
Tim Murphy
Nick Martin
Ruben Osorio

Dr. Yunjun Xu – Faculty Advisor
Carlos Velez – Technical Advisor
Steven Helkin – Technical Advisor

Sponsored by Harris & Progress Energy

The Damage

Over 95,000 wells have been drilled in Gulf of Mexico since 1938.
More than 27,000 wells have been permanently abandoned.
Oil well leaks can be caused by several factors:
- A well can repressurize.
- A faulty seal on the well-head.
- Cracks or shrinkage of cement in well.
- Corrosion of the steel liner.
Due to depths of the wells and Gulf of Mexico currents, leaks cannot be detected from the surface.
Abandoned wells are not currently checked for leaks by government or industry.

The Need

The Science of Detection

Thanks to a unique atomic phenomenon known as fluorescence, we will be able to “see” leaking oil.

Fluorometer would be placed on top of contraction section on the funnel.

Fluorescence: emission of light by a substance that absorbed EM radiation of a different wavelength.

Oil is excited by radiation in the ultraviolet region (300 – 400 nm).

Oil emits radiation in the visible light region (410 – 600 nm).

Project Description

Design, Build, and Test a monitoring system capable of detecting and reporting crude oil leaks from underwater abandoned oil wells.

Key Design Requirements:
- Must detect the presence of crude oil
- Minimal Power Consumption
- Wireless transmission of data once surfaced
In order to provide a monitoring system for abandoned oil wells, a mechanical senior design team designed, tested, and built a fully powered and automated oil detection system for end users such as the EPA. The system acts like a cap to be installed on the top of all abandoned oil wells. The cap is shaped like a nozzle, which forces any leaking oil from the well to flow out through the nozzle and through a channel where a series of sensors detect for the presence of oil.

Various sensors were considered for this task. The team concluded that the use of a fluorometer and pressure sensor would work best for detecting the presence of oil. The fluorometer is an electronic sensor which can detect the presence of oil in water through the use of the luminescent properties of oil.

The second sensor is a pressure transducer which can detect the presence of oil in the configuration designed by this group by detecting a pressure drop. Minimal power is consumed by each of these sensors with total power consumption equal to about 360 mW. The final requirement to be able to wirelessly transmit the signal produced by the fluorometer and pressure transducer was accomplished through the use of a product called a Wi-Ranger. The actual oceanic design consists of the two sensors and a data acquisition system attached to the funnel design, which encapsulates any leaking oil from an abandoned oil well.

The data acquisition system, which is housed in a hermetic electronics enclosure, would convert the signal from the sensors into a useable and interpretable signal. A wire from the data acquisition system would be connected to the buoy, which also provides the power for the sensors, on the surface of the water where the signal could be transmitted wirelessly.
Selections Team Criteria

- **Systems Selection:**
  - Design the “right size” HVAC system
  - Improve Building to ASHRAE 189.1
    - Standard for Design for High Performance Green Buildings
    - In the near future, this standard will become implemented in building code
  - Review 3 different HVAC systems
  - Find the best solution:
    - Life Cycle Cost
    - Environmental Impact
    - Comfort and Health
    - Green Design
    - Architectural Synergy

Roof Top DX System

- Direct Expansion System DX (Roof Top Units)
  - Packaged Unit on roof
  - Easiest System for Maintenance to work on
  - Initial Installation Costs lower than Chilled Water/Boiler Systems and VRV

Hydronic System

- Hydronic (Chilled Water/Boiler System)
  - Chilled or heated water is pumped to different parts of the building
  - Air is blown across water pipes to heat or cool it
  - Better indoor Air Quality than VRF and allows more zone control than DX systems

Variable Refrigerant Flow System

- Variable Refrigerant Flow (VRF) system
  - Similar to a DX system, except with variation in refrigerant flow.
  - Instead of cycle on/off, flow of refrigerant is adjusted to meet demand
  - Can perform simultaneous heating and cooling of zones.
ASHRAE is the American Society for Heating, Refrigeration, and Air Conditioning Engineers. They are an international organization with over 51,000 members worldwide which governs the design of HVAC (heating, ventilation, and air conditioning) systems throughout the United States by having their standards implemented into building codes.

The Drake Well Museum has been chosen as the site for the 2011 ASHRAE International Design Competition. This facility is the location of the world’s first oil well. The museum has been closed since 2009 to undergo extensive renovations to the facility. Part of these renovation plans is to make the HVAC system more energy efficient.

The Systems Selection portion of the competition encourages students to use a life-cycle cost process to select the building’s HVAC system as well as incorporate the sustainability process promoted by ASHRAE. This is done by designing the system to ASHRAE standard 189.1- Standard for the Design of High-Performance Green Buildings and following the US Green Building Council’s LEED (Leadership in Energy and Environmental Design) rating system.

The requirements of the competition are straightforward. The HVAC Systems Selection team is required to first determine the building’s cooling and heating loads in order to determine the “right size” HVAC system for the facility. Autodesk REVIT was chosen as the software suite to determine these loads. REVIT is a BIM (building information modeling) program that is able to simulate all the loads placed on a facility throughout its entire lifecycle. From these calculated loads, the correct sizing of the equipment can be chosen and evaluated further. There is a budget of 2.4 million dollars for the mock design in which the HVAC system and building envelope are to be improved.

Three systems will be evaluated for this facility for the competition. A packaged roof top direct expansion unit will serve as the baseline system to be compared to. Roof top air handler units are the most common type of system used today in commercial buildings. They are usually the least costly to install and have average operations and maintenance costs. Compared to the some other technologies, they have a fairly short life cycle and may need to be replaced sooner. The second type of system that will be evaluated for this project is Variable Refrigerant Flow (VRF) system coupled with a rooftop unit. The VRF system is less costly to install as there is much smaller piping and less ductwork to deal with. It is able to simultaneously heat and cool multiple zones. The drawback is that it is unable to cope with humidity control so dedicated outside air units in the form of Roof Top DX air handlers must be incorporated with its design. The final system to be evaluated is a hydronic system. This system will send water through pipes to heat exchangers located throughout the facility to heat and cool the building. The water would be cooled by a chiller plant and through the use of a boiler when heat is needed. This system is very efficient but has a higher initial cost when compared to the other two systems.

These systems will be compared through the use of energy modeling and the system with the shortest payback period and lowest overall cost will be chosen pending they meet the facility owners criterion. In this case the VRF system was chosen as the best recommendation for the Drake Well Museum. This system was able to meet all the requirements of the Pennsylvania Historical Museum Committee while proving to be the best overall value.
DEPARTMENT OF MECHANICAL, MATERIAL & AEROSPACE ENGINEERING

Burns Bradford
Matthew Basnight
William Bradford
Orion Dominguez
Daniel Kroencke
Dustin Yoder

Dr. Marcel Ilie – Faculty Advisor
Nate Boyd – Technical Advisor

Sponsored by ASHRAE & Progress Energy

What is ASHRAE

American Society of Heating, Refrigerating and Air Conditioning Engineers, established in 1894
International Organization
51,000 members
Chapters in 130 countries

Provides guidelines for US Government to establish energy guidelines for all buildings

Our mission: "To advance the arts and sciences of heating, ventilating, air conditioning and refrigerating to serve humanity and promote a sustainable world"

Local Power Generation Through Wind

- Honeywell WT6500, the latest in blade tip power generation wind turbines
- 6 ft diameter, 188lbs
- Working range of 2 – 38 mph winds
- $6,650 net Installed Cost after $3,000 in state and federal incentives
- Annual generation of 1300 kWh per unit based on local wind conditions pulled from NASA
- Payback period of 8 years compared to 11 years for solar cells in this area
- Estimated 13 tons of CO₂ saved over 15 year life-span for each unit
In order to do this, the team performed load calculations to find the amount of heating and cooling energy necessary to properly condition the museum. An HVAC system and alternative energy components were then selected to meet the museum’s needs. Based upon these requirements, a Variable Refrigerant Flow system coupled with a high efficiency Dedicated Outside Air System (DOAS) were selected to provide heating and cooling for the building. Through our efforts to achieve a Net Zero Energy Building (NZEB) design, renewable energy technologies were researched and a photovoltaic system (PV) has been selected in order to provide an alternate source of energy to the building.

The project’s design not only met these requirements, but exceeded them by achieving a possible rating of LEED Gold and staying well below the theoretical budget given for both the Mechanical, Electrical, and Plumbing (MEP) requirements and the building envelope requirements.
DEPARTMENT OF MECHANICAL, MATERIAL & AEROSPACE ENGINEERING

Purpose

- Overall goal is to design an efficient, scalable turbine for marine use, which will help to prevent future large-scale oil spills, such as the BP oil spill in the Gulf.

Performance Analysis

- Integration:
  - Plan is to integrate turbine with buoy and sensor system to monitor potential oil leaks
- Efficiency: 30%
- Expected Power:
  - 100W (peak) – average 30 W (21.6 kW/hr)
- Cost Analysis:
  - Full scale overall cost ≈ $11,000 (based on initial design)
  - Production would be $24k per year
  - Investment return is 170 days

Prototype

- Purpose
  - Powers a system to monitor abandoned oil wells
  - System detects very small amounts of oil, preventing large-scale leaks from occurring
  - Possible EPA mandated monitoring of abandoned wells
- Environmental Challenge
  - Materials chosen to work in corrosive, salt water environments
  - Designed to have minimal effect on marine life
Bi-Directional Hydro-Turbine

The purpose of this project is to design a turbine that will operate in conjunction with an ocean buoy to harness the latent energy of ocean waves. A generator is placed within the buoy to convert the mechanical power of the turbine into usable electric power by way of a shaft connecting the buoy and turbine. This generated electricity is then used to power an oil leak sensor device that would be able to detect oil leaks at abandoned, off-shore oil rig sites. This design will be invaluable if governmental regulations were to change and require that oil companies monitor every abandoned oil well for possible leaks. This change may be imminent due to the recent BP oil leak fiasco in the Gulf of Mexico.

The turbine consists of a converging-diverging duct that encloses all of the moving parts. This shell looks like an hourglass and tapers outward at each end, so that, as the wave drives the buoy up and down, the flow induced in the turbine duct is accelerated to increase the velocity of the water. The middle portion of the duct houses the turbine rotor (blades) and the stators (guide vanes). The guide vanes are placed above and below the blades and are designed in such a way that the turbine blades will spin in only one direction whether the buoy and turbine are moving up or down with the wave. The turbine blades are designed symmetrically so that, no matter the direction of the water flow through the turbine, they will experience a substantial force capable of rotating the blades and generator shaft. This type of turbine has never been designed before. Other similar devices have been designed, but they only generate power on either the up-stroke or down-stroke of the wave motion. This turbine is designed to produce power on both, thereby doubling the power produced.

The first thing to be done was an analysis of the turbine geometry. The turbine needed to be symmetric about the horizontal center axis. This was accomplished by creating the blades as a crescent moon shape. Guide vanes were implemented above and below the blades to “swirl” the water into a whirlpool like motion to create a horizontal component of velocity that would be more useful to the blades instead of a purely vertical flow field. These guide vanes are fixed within the duct, while the blades and shaft connecting the turbine to the generator are free to rotate. The duct’s hourglass shape was designed to act as a nozzle; as the cross-sectional area of the duct decreases, the velocity of the water is increased thereby gaining momentum. Since this turbine would be placed near abandoned oil wells in the Gulf, typical wave heights and wavelengths are insufficient and require augmentation to provide the means for substantial power generation.

A scaled-down model of the turbine was created by Harris Corporation using an FDM (Fused Deposition Modeling) machine. It was constructed of ABS plastic and assembled by the team. A shaft and ball bearings were procured and installed for ease of the moving parts of the turbine. The testing of the turbine was performed using a table that was programmed to mimic the motion of ocean waves. The turbine was rigidly attached to the table and dunked repeatedly into a 55-gallon drum filled with water. Measurements were taken using a data acquisition system known as Labview and an optical RPM (revolutions per minute) sensor. From the RPM data recorded, estimates of Torque and power produced were generated.

The small-scale model produced a maximum of 35 RPM, but the prototype and testing size limitation is only a model for the real potential of the project. It is expected that the full-size model will be able to reach an RPM of approximately 80, and the generated power expected from the full size model is near 100 Watts. This amount is more than sufficient to power the oil leak sensor for which it was designed and to work well in conjunction with the attached ocean buoy.
Environmental Wind Tunnel

DEPARTMENT OF MECHANICAL, MATERIAL & AEROSPACE ENGINEERING

Anthony Bravato
Joseph Butera
David Giesecke
Christopher Gonzalez
James Ingram

Dr. Jihuan Gou – Faculty Advisor
Dr. Jayanta Kapat – Technical Advisor

Sponsored by Progress Energy

Wind Energy: Relevance and Growth

- Renewable energy sources contribute 18.8% of the total energy generated.
- Wind energy accounts for over 10% of renewable energy sources.
- From 2000-2010, wind turbines-generated electricity grew at 37%
- Present projections show continued positive growth.

Source: IEA, Energy Information Administration, 2011 International Energy Outlook

Consequences of Turbine Blade Failure

- Turbine-blade failure accounts for 2.3% of annual turbine downtime.
- Along with icing and insect infestation, surface erosion is a leading cause of blade failure.

Source: E. F. D. Samaraweera (2005)

Research Solution: Environmental Wind Tunnel

- Accelerated degradation of materials can be achieved through:
  - High wind velocities (up to 140 mph),
  - Facility exposure to rain,
  - Environmental simulation: 360° wind tunnel,

- Uniform particulate distribution through:
  - Front particulate injection (150° range),
  - Wall convection/eddy flow by way of proven tunnel design,

Simulation of Cost-Benefit Analysis

- For numerical demonstration, specifications from L. Madrider and M’s 2007 DOWEC-based optimization model were utilized.

- DO WEC model simulation details:
  - Binary, 3-bale turbines
  - Nominal output rate of 450 MW
  - Annual turbine availability due to blade-related issues at 1.8%
  - 1.8% = 106.8者/年

- Annual cost of electricity:
  - $1.09

- Does a real potential for saving FF

Simulated Cost-Benefit Analysis Results

- Loss of revenue due to blade-related downtime:
  - $0.5 million

- For control turbines, a conservative assumption of 8% reduction in annual output is necessary.

- Revenue loss after blade-coating enhancement:
  - $7.5 million

- Revenue retained due to blade-coating: $11.2 million

Annual Revenue Loss Due to Blade Surface Failure

- Annual revenue loss due to blade surface failure:
  - $2.0 million

Sponsored by Progress Energy

UCF Stands For Opportunity®
In an era when non-renewable energy-generating resources are coming under increased scrutiny and reduced availability, sources of clean and renewable energy are quickly becoming more useful and relevant. Research methods which can not only increase the life-expectancy of wind turbine blades, but also decrease the overall cost of turbine operations, are advantageous to both the energy supplier and consumer.

The Environmental Wind Tunnel (E.W.T), currently in the design phase at the University of Central Florida will allow researchers to better understand, predict and prevent the material degradation of wind-turbine blades being utilized in harsh conditions such as those prevalent in desert and coastal regions. Through the use of an advanced particulate dispersion system located inside an open-circuit wind-tunnel, sand and salt water, both primary causes for material corrosion and damage, will be uniformly injected into high-velocity wind profiles and across various material cross-sections commonly used in the manufacturing of turbine blades in an effort to simulate the long-term degradation of materials in an accelerated fashion. The faculty, staff and students associated with E.W.T sincerely believe that advancements in material development and coatings obtained through research conducted with this particular wind-tunnel have the potential to help preserve precious natural resources while allowing communities to more successfully strive for carbon-neutrality. This design team looks forward to not only satisfying, but also surpassing customer expectations while helping the University of Central Florida become a leader in energy sustainability research.
Fuel Cell Powered UAV

DEPARTMENT OF MECHANICAL, MATERIAL & AEROSPACE ENGINEERING

Adam A. Boutin
Joseph J. Breitenbach
Lauren M. Ferlita
Nathan C. Fist
Adriano J. Rampolla
Curtis R. Schneider

Dr. Yunjun Xu – Faculty Advisor
Sponsored by Progress Energy

Advantages

- Efficiency
  - Approximately 40% at 28 V
- Low Maintenance
- Fuel Weight
- Fuel Flexibility
  - Less dependency on Fossil Fuels
- Less Susceptible to Structural Weakness or Corrosion

Driving Factors

- Environmental Pollution (Noise, Fuel, Exhaust Etc.)
  - “Charles Lindenburg ended life regarding air travel as mere squiggle and aviation in general as one of the world’s serious environmental problems.” (Morrow, Lance. “Aerial Pollution: The Sky Has Its Limits.” Time Magazine. 07 May 2001; Print)
  - The pollution from just one, two-minute 747 takeoff is equal to operating 2.4 million lawnmowers simultaneously.
  - Jet fuels are responsible for about 3 percent of overall carbon dioxide emissions in the U.S. and is expected to rise 60% by 2025.

Purpose and Goals

- Utilize a PEM Fuel Cell to power an Unmanned Aerial Vehicle (UAV)

- Goals:
  - Achieve stable flight
  - Fly for a duration of two hours under fuel cell power

Applications

- Military
  - Combat
  - Surveillance
- Law Enforcement
  - Border Security
  - Traffic Monitoring
  - Home Land Security
- Crop Monitoring
- Over Sea Oil Well Monitoring
- Recreational

UCF Stands For Opportunity®
Utilization of a Proton Exchange Membrane Fuel Cell in an Unmanned Aerial Vehicle

An unmanned aerial vehicle (UAV) was designed to achieve stable flight while being powered by a 200W proton exchange membrane (PEM) fuel cell. Flight tests were performed to prove the flight capabilities of the UAV as well as the efficiency of the UAV’s power system. The results of the testing phase showed that the UAV could take-off, achieve stable flight, and land successfully while being powered by a PEM fuel cell. It was also confirmed that the aircraft could withstand an extended flight time of 90 minutes. With an ever-increasing need for new aviation fuel sources, fuel cells have been looked at as one of the most efficient sources of alternative energy for aircraft.

PEM fuel cells have an efficiency rating of approximately 40-60%, in comparison to diesel and gasoline electric, and steam and gas turbines with efficiencies ranging from 5% to 35%. In addition to efficiency, “fuel cells enable longer flight times, quieter operation, less heat signature, and higher reliability than batteries or other methods of propulsion for many UAV’s” [1]. More importantly the only by-products of PEM fuel cells are pure water and heat, enabling the system to have no negative impacts on the environment. The absence of carbon dioxide emissions from PEM fuel cells makes this form of power a desirable alternative to current fossil fuels that are “responsible for about three percent of overall carbon dioxide emissions in the United States, and the U.S. Federal Aviation Administration expects domestic aircraft emissions to rise 60 percent by 2025” [3]. Due to the vast number of benefits offered by PEM fuel cells, they can be utilized as an alternative power source in various aviation applications such as military and commercial surveillance, border security, traffic monitoring, crop monitoring, as well as military combat.

Testing the fuel cell UAV was performed in two stages. The first stage was to test the electrical setup. This was completed by first using two batteries; one that represented the PEM fuel cell and the other being the back-up battery. This electrical set-up was proven successful, therefore one of the batteries was replaced with the PEM fuel cell and the test was run again to prove the final concept functional. The second stage of testing was then commenced following the validation of the electrical system, which was composed of verifying the UAV’s flight capabilities. The aircraft was tested to insure that it could support the weight of the internal payload while in-flight. It was determined the UAV could sustain flight with the required weight, therefore the PEM fuel cell was inserted into the UAV and verification flights were performed. The UAV flew successfully over a flight time of 90 minutes, with the use of the PEM fuel cell.
DEPARTMENT OF MECHANICAL, MATERIAL & AEROSPACE ENGINEERING

Van Truong
Sung Kim
Andrew Shon

Dr. Yunjun Xu – Faculty Advisor
Sponsored by Progress Energy

Purpose
Why did we do this?
• Conservation of Energy
• Substantial Energy is Wasted

What can we do?
• Recapture
• Recycle
• Recharge

Project Goals
• Recycle braking energy into usable electricity
• Integrate super capacitors into a regenerative braking system
• Use a go-kart as a small scale test platform: cost effective
• Maximize input energy vs. output

How Can We Accomplish This?
Regenerative Braking
• Converts kinetic energy into electricity

How does it work?
• Duality of electric motors (motor vs. generator)
• Motor does braking
• Torque reversal counteracts forward momentum

The Bigger Picture
Current Technology
• Tesla Roadster has 88% efficiency
• 3x efficient over ICE

Current Usage
• 250 million consumer vehicles in U.S. alone
• 44% of world’s gasoline consumption
• 360 million gallons daily
Hybrid Go-Kart with Super Capacitor Boost

Many design teams start with customer requirements and restrictions. The RBSCS team, however, does not like restriction. They decided to find an everyday problem and define their own requirements to solve this problem. In the midst of this definition, the RBSCS go-kart was born. The regenerative braking & super capacitor system on a go-kart platform is the solution to a prevalent, yet rarely acknowledged, problem. The problem lies in the energy that is wasted every time the brakes are applied in any automobile. Instead of wasting the kinetic energy of the vehicle by using screeching, dust-ridden brake pads, that kinetic energy can be recycled.

Subsequently, the regenerative braking and super-capacitor boost system (RBSCS) on a go-kart platform is the solution and final product that our design team has executed. The go-kart itself was used to successfully demonstrate regenerative braking. Although, regenerative braking is not current breakthrough technology; what makes the RBSCS unique is its use of capacitors to act as a buffer between the electric generation and the battery pack. The capacitors are able to build charge from kinetic energy that is converted into electricity. The RBSCS is able to dump this capacitor charge into the system for a power boost via a boost button, located remotely on the steering wheel.

Pictured below is the prototype for the RBSCS go-kart. This report will provide and illustrate the detailed design, as well as outline the conceptual design, configuration design, and the parametric design.
DEPARTMENT OF MECHANICAL, MATERIAL & AEROSPACE ENGINEERING

Mark Donohue
Steven Hampson
William Wynn

Dr. Nina Orlovskaia – Faculty Advisor

Sponsored by Progress Energy

NEED
- Most automobiles brake without regenerative power, wasting energy and releasing it as heat.
- Hydraulics provide a method to capture the majority of this energy.
- Increase fuel efficiency by up to 40%.
- Attractive for large vehicles that stop frequently.
- No existing parallel kits available.
- Current adopters include Chrysler and UPS.

GOALS & REQUIREMENTS
- Capture braking energy in a usable form.
- Use the captured energy in ensuing acceleration.
- Require little to no additional operations from driver.
- Be safe during operation.
  - Design redundant safety systems to prevent catastrophic failure.
  - Provide adequate braking power.
  - Defined based on current braking power of vehicle.

WHY NOT ELECTRIC REGENERATIVE BRAKING?
- Electric
  - Low power density.
  - Requires specialized technicians.
  - Requires mechanical braking assistance.
- Hydraulic
  - Significantly reduced weight per power output requirements.
  - Scalable for different applications.
  - Materials used are more environmentally friendly.

FINISHED PROJECT
- Parker P1/PD Over-center, Variable Displacement Pump.
- 2.5 Gallon Piston Accumulator.
  - Capable of Capturing 27.4 kJ of kinetic energy.
  - Adjustable braking distance to match that of vehicle.
  - Currently testing improvements in efficiency and fuel economy.
Our project focuses on capturing the energy normally lost as heat during vehicular braking and using this captured energy in assisting the subsequent acceleration of the vehicle. For our project, we will be using a golf cart as the platform for the system to provide a proof of concept of the technology on a small scale. This technology is capable of increasing the fuel efficiency while lowering the carbon emissions of current vehicles. Hydraulic hybrid systems have already been proven to improve fuel efficiency of large vehicles such as delivery trucks and dump trucks through initiatives by Eaton in producing a Hydraulic Launch-Assisted fleet of UPS trucks and the implementation in a fleet of garbage trucks in Miami.

Our project seeks to explore the viability of this technology on a smaller scale. In order to accomplish this we developed a system specially adapted for a utility golf cart. This required the team to first tap into the existing drive train through a shaft extension and pulley. Through connecting to this pulley the system was able to capture the vehicle’s kinetic energy, store it as pressure within the accumulator and then use the stored energy to assist in propelling the vehicle forward. This was accomplished by using a reversible hydraulic pump controlled by electronic inputs. These electronic signals were supplied by potentiometers connected to the vehicle’s existing pedals so that no additional operations were required from the driver. Based on preliminary calculations we estimated the vehicle will be capable of capturing 12.73 kJ energy with 0.5 gallons of hydraulic fluid. The stopping distance will be adjustable through controlling the displacement of the pump. The ensuing acceleration will carry the vehicle up to 60 ft with an average torque of 18.7 ft-lbs.
DEPARTMENT OF MECHANICAL, MATERIAL & AEROSPACE ENGINEERING

Daniel Bell
Boran Kim
Chris Walker
Matt Penn
Dr. Marcel Ilie – Faculty Advisor
Carlos Velez – Advisor
Mark Blue – Technical Advisor

Sponsored by Harris & Progress Energy

Why Wave Power?
Ocean Waves poses greater energy compared with Wind energy
Location and direction of waves can be identified easier than wind direction
Majority of Earth’s surface is water, therefore wave energy can be tapped from almost anywhere

Power Generation Concept

The Design
Outer hollow shaft prevents horizontal forces to interrupt turbine shaft rotation and prevents water entering generator housing
Generator housing swivel ensures complete vertical position of the turbine housing

Experiments
Outer Shaft was tested to determine if horizontal forces will deform the shaft and interfere with the turbine shaft
Experiments show that the deflection of the outer shaft will not interfere with the turbine shaft up to a force of 10 pounds
The purpose of this paper is to outline the development of the power generation buoy as requested by the Harris Corporation.

The product was requested to work on the principle of the Airy wave theory for deepwater conditions. Under these conditions the water particle velocities approach zero quickly as the distance from the surface approaches greater than one wavelength. The purpose of our product is to maximize movement with respect to the surface wave, therefore maximizing the velocity through the turbine.

Figure A1 illustrates the main components bellow.

The main components of our design are as follows:

1. Buoy
2. Swivel
3. Generator Housing
4. Turbine Housing
5. Shaft Assembly

Figure A1 – Turbine assembly
**Prometheus Alpha Overview**

- Prometheus Alpha is a portable, small-scale Organic Rankine Cycle (ORC) System which can help overcome the need for fossil-fuel energy sources and other resource-dependent generators.

- The ORC implements an organic fluid (Perfluorin) with a boiling temperature lower than the heat source temperatures.

- The phase-change of the working fluid creates a pressure difference in the system which drives the turbine resulting in output mechanical work. This work can be converted into electrical power.

- The ORC system can be used in conjunction with geothermal, industrial waste-heat, and solar heat sources.

**Methodology**

- Turbine-based electrical generator that is both portable and efficient

- Energy is provided by solar heated water (no refueling required)

- Would create 100 A of A/C current (enough for small electrical devices)

- Assembled from standard components (auto parts)

- Design is completely scalable and low maintenance

**Design Purpose**

- Prometheus Alpha is marketable as an alternative to portable, internal combustion-based generators.

- The system can be used for personnel use in the happening of power outages, natural disasters, and for living in remote locations.

- The system can be used in the commercial sector by implementing waste heat into the system to generate some of its own power. On a larger scale, this system could be used as a temporary power grid in remote locations.

**Outcomes**

- Overall design is sound

- Heat exchanger design only requires temperatures of 45°C in the boiler & 16°C in the condenser

- Fuel pump and water pumps function properly

- Turbocompressor was not designed to be vapor-tight and leaks cause pressure issues

- Turbine component would need to be redesigned to suit needs
Organic Rankine Cycle

Electricity is essential to the growth of nations. Whether it’s being used to power heavy machinery or provide light at night, electricity, and the means for generating it, is the biggest enabler to a nation’s growth in this age of time. This report goes through design concept to manufacturing and assembly to final prototype design. Beginning with the initial design concept, using car parts for an Organic Rankine Cycle (ORC), the system is displayed at different points in the development phase; highlighting the design thoughts and considerations taken throughout the design and build period.

Following the design background, the prototype design is discussed, going through the design methodology and modifications. Supporting data and procedure of troubleshooting is provided in full. Manufacturing and assembly is presented with progressive instructions as well as assembly drawings. Prototype testing and evaluation is provided along with the user manual. Finally, the conclusion of the project and recommendations for teams in the future is discussed.
DEPARTMENT OF MECHANICAL, MATERIAL & AEROSPACE ENGINEERING

Jared Clark
Alex Gardner
Kyle Little
James Livingston
Leah Vanlear

Dr. Kurt Lin – Project Head
Dr. Yunjun Xu – Faculty Advisor
Dr. Weiwei Deng – Technical Advisor

Sponsored by Progress Energy

Why a Balloon?

- Capture more direct and diffuse light
- Low maintenance
- Inexpensive
- Portable
- Beautiful

Our Project

- Scaled model to determine optimal balloon placement

Applications

- Portable with simple installation
- Useful in a variety of locations
  - Space constraints
  - Off-grid
  - Aesthetic
- Emergency power source

SunHope Balloon System

- Helium filled platforms
- PVA coated fabric
- Simple infrastructure
  - Control panel
  - Helium supply line
  - Power cable
Solar Balloon System

As the United States continues to search for new energy alternatives and ways to escape its reliance on oil, methods to capture and use the energy of the Sun have become viable solutions. One of these alternative energy options is the use of solar balloons. This relatively new idea has not yet been widely accepted, and an apparatus that can be used to test the effectiveness of these balloons without actually having to build them may reveal that they are an excellent option for creating energy for the future.

Four main components were constructed and then combined to make the final apparatus. These components include a light source, model environments, a motion mechanism, and a model solar balloon. Each component was designed to represent real-world objects or occurrences; the light source represents the Sun, the model environments represent actual areas in the Central Florida area (one for Downtown Orlando and one for Lake Pickett), the motion mechanism is used to mimic the Earth’s rotation with respect to the Sun, and the model solar balloon represents a full-scale solar balloon.

Once the apparatus was completed, it was used to test the effectiveness of the model solar balloon in each model environment. The following image depicts the apparatus with the Lake Pickett environment on the test platform.

Once testing was completed, it was determined that the Downtown Orlando model directed more light towards the solar balloon when compared to the Lake Pickett model. This suggests that solar balloons placed in highly developed city areas are likely to produce more energy than balloons that are located in lake environments.
DEPARTMENT OF MECHANICAL, MATERIAL & AEROSPACE ENGINEERING

Connie Griesemer
Danny Gould
Jonathan Torres
Ryan Tribbey
Ryan Lewis

Dr. Nina Orlovskaya – Faculty Advisor
Patrick Robinson – Technical Advisor
James Nelson – Technical Advisor

Sponsored by Department of Sustainability and Energy Management & Progress Energy

Purpose: UCF’s Climate Action Plan

- In 2008 UCF spent $12.5 Million in Electrical Consumption
  - Approximately 4-9% increase annually
- February 2007 President Hitt took a stand for sustainability and to become a climate neutral campus by 2050

UCF Solar Farm – Project Site

Area of Site – 3 Acres; equivalent to 0.6 MW

Side Profile – Attachment System

Wind Load Analysis
(Wind Flowing Back to Front)

Set at Optimal Angle of 29°
The University of Central Florida (UCF) is currently employing a five step plan to become climate-neutral by 2050, including the utilization of renewable energy sources. With the limited amount of non-renewable resources available and the cost of energy rising annually, it is important that UCF begins to produce their own energy to lower power consumption from the grid while also reducing their carbon footprint. The purpose of this project was to design and engineer the mounting system for a photovoltaic array that will be replicated over time to construct an on-campus three-acre solar farm. The guidelines for the project were to design an economically viable mounting system that could also be assembled by an unskilled labor team.

The module design had to satisfy Orange County building code parameters of withstanding 130 mph 3-second peak gusts as well as last the life of the solar panels, which is approximately 25 years. Research for the project was conducted at the Kennedy Space Center as well as the Florida Solar Energy Center.

Several designs were considered, but the final design selected was the best fit for the project guidelines. Stress, corrosion, and wind-load analyses were conducted on the selected design to ensure that it would not fail or corrode throughout the life of the solar panels. The selected design uses two parallel tubular steel systems, one of which has a shorter height to effectively create the angle of 29.77° (or ~30°) for optimal year round solar collection. Elbow and T-style Kee Klamps were utilized at each rail and post connection. Using the Kee Klamps eliminated the need for skilled labor, such as welding or bending, allowing this design to adhere to the two main guidelines. The module uses galvanized steel, which will not begin to corrode until well after the life of the solar panels. The overall size of the 11-panel module is 40 ft by 6 ft and secured to the ground by concrete anchors. The size and depth of the anchors was determined through a soil analysis performed at the site. The combined weight of the anchors and the unit itself are enough to counteract the maximum lifting force that the unit must be able to withstand as stated by the Orange County Building code. The ground surrounding the module will be covered in white rock to prevent any weeds from growing around the system that may cast a shadow on the solar panels, as well as add additional weight to the system.
DEPARTMENT OF MECHANICAL, MATERIAL & AEROSPACE ENGINEERING

Solar Powered Car Cooler

David Amos
Daniel Beckett
Justin King
Robert Wallace

Dr. Marcel Ilie – Faculty Advisor
Sponsored by Progress Energy

Problem Description and Objective
- Interior temperatures can reach up to 140°F under direct sunlight
- Creates adverse health and operational conditions within the automobile for users and equipment
- Design a solar powered device that will produce a steady-state interior temperature of ≤ 85°F
- System must be autonomous and unobtrusive to passengers

Evolution of the Design
- To improve marketability of the solar cooler, the following advances must be made:
  - More efficient and flexible Solar Panels
  - High energy density, compact, lightweight batteries
  - Establishing manufacturer support for expensive components, current price tag $5,000 USD
- From market research, possible applications of solar powered cooler:
  - Self-Sustainable/Pre-fabricated housing
  - Residential and Commercial cooling
  - Remote Military and Scientific outposts
  - Automotive cooling

Economics
- Approximately 17.6% of total U.S. electricity consumption in 2008 was used for cooling
- Steadily increasing electricity and fuel prices
- 20% of greenhouse gas emissions come from home energy use

Documentation of Consumer Interest
- Government and Defense
  - Nellis AFB PV Array
  - Numerous National Guard PV projects
- Self-sustainable housing
- Toyota Prius car ventilation system
Solar Powered Car Cooler

The interior cabin of a motor vehicle can reach a temperature of up to 140°F if left in direct sunlight for a period of time. These conditions can create an uncomfortable and potentially hazardous environment for passengers and cargo alike. The goal of this project was to construct a cooling system, separate from the factory air conditioning system that will efficiently and autonomously cool the car to a temperature of 85°F or less for a period of no less than 2 hours. Using several heat load calculators utilized in the refrigeration industry, the heat capacity required to cool the total volume of the cabin was at most 4400 btuh.

A vapor-compression refrigeration system, similar to a normal household air conditioner, was chosen to meet these cooling requirements. The compressor pumps refrigerant-134a through the condenser and evaporator. A fan will blow air over both the condenser and evaporator, expelling hot air from the system and pushing cool air into the cabin of the car, respectively.

The compressor was undoubtedly the key to the project, and it was for this reason most of the research done was dedicated to finding a suitable compressor. Choosing an appropriate compressor would ultimately determine the overall success of the project. Research determined that the most suitable compressor for this application was the Masterflux Sierra 02-0434Y3. The Sierra model is a variable speed compressor, which will allow the cooling capacity of the system to be controlled, along with the required input power. The condenser and evaporator were then chosen to optimize the efficiency of the system based on the output of the compressor. The next step was to acquire fans with a large enough CFM rating to push air past the condenser and evaporator. The final variable to consider for the project was the power source. Because the total power requirement of all the components of the system was larger than the output of the solar panel, a battery bank was implemented. The solar panels in turn would charge the batteries. The battery bank used comprised of six (6) Optima BT-D27F batteries, wired for an output voltage of 24V. The components of the system will be housed in the cargo area of the vehicle. During sunny conditions with occasional clouds, the system was able to maintain a 4°F difference between the outside air and car interior for 6.25 hours. The system shut down after this time due to a low voltage condition on the battery banks. While the system was able to meet the goal of maintaining an interior temperature of 85°F or less during the testing period, it would not be expected to do so under the harsh temperatures of summer. This problem was traced back to inadequate insulation between the high and low pressure portions of the system (the hot and cold sides, respectively). Due to the additional heat load placed on the system, its ability to remove heat from the interior of the car was severely restricted. With adequate insulation installed and the two sides of the system thermally isolated, a high degree of confidence would be given to the ability of the system to exceed all design benchmarks regardless of the season.

As the efficiency of solar panels improves through the coming years, the size of this system, mainly the battery bank, will inherently decrease. This will drastically decrease the weight and the space that the system takes away from the trunk of the vehicle. Additional improvements could be realized through the addition of a central operating system which would improve the efficiency of the system by shutting it down when cooling was not required. Eventually the system may be able to be run entirely on the power output of the solar panels, although a small battery bank would still be required due to lulls in solar energy throughout the course of the day. This project is a proof of concept showing how solar power can be implemented in many cooling applications. This will eventually eliminate carbon emissions from air conditioning systems, which is the main reason for moving to a clean and renewable energy source in the near future.
**Project Goals**

- Heat water to 100°C to sterilize the water
  - At 65°C kills off germs and viruses that cause cholera and hepatitis A and B
  - Continued heating to boiling point will kill off remaining bacteria
- Provide 500 liters of water per day
  - Will provide water for drinking and cooking for roughly 75 people
- Follow the sun throughout the day
  - Increase efficiency of device and will therefore decrease heating time
- Three months of no maintenance

**Benefits**

- Solar Energy is infinitely renewable
- Non-polluting device
- After initial installation, device will require little to no maintenance
- Solar Heating is Federal Income Tax Deduction

**Purpose**

- Provide safe drinking water for developing countries
- 18% of world population has no access to safe water supply, according to World Health Organization
- Save energy heating and boiling water
  - Water Heating can account for 14%-25% of the energy consumed in the average home
- To create a simple design that can be easily replicated at almost any location.

**Secondary Applications**

- Radiant Heating
- Hot tub, swimming pool, and spa heating
- Solar Washing Machine
- Air conditioning
- Electricity Generation
Solar Trough for Hot Water

A parabolic trough collector was designed, constructed, and tested to provide safe drinking water for third world countries. Requirements included to heat the water to 85°C for 15 minutes, provide 500 Liters per day, follow the sun throughout the day, and require no maintenance for three months. A computer model of the design was created to help with the construction process. The construction consisted of the support structure, individual troughs, linkage system, and solar tracking assembly. Testing revealed that the temperatures were reached within one hour.

Refilling each hour and heating for eight hours a day, a total of 400 Liters were able to be provided. The troughs were able to follow the sun with no problem and the trough design provided storm protection and satisfied the no maintenance requirement. The trough efficiency was 71.2% and could be increased by adding an evacuated glass tube. This would improve the design and allow for the 500 Liters requirement to be met.
DEPARTMENT OF ELECTRICAL ENGINEERING and COMPUTER SCIENCE

The Department of EECS is a hidden gem of opportunities in education and research, providing undergraduate and advanced degrees in the Renaissance Careers of the future. Computer Science and Engineering graduates are consistently among the highest paid jobs in today's work force. CareerBuilder.com recently reported that Computer Science graduates from the Class of 2008 had salary offers rise 7.9% and engineering graduates rose 5.7% over those of 2007. The Department of EECS offers Bachelors, BS MS (5-yr), Masters and Doctorate degrees in Computer Science, Computer Engineering and Electrical Engineering, as well as a Bachelors degree in Information Technology.

EECS Undergraduate students also have an outstanding opportunity to earn their Bachelors degree with Honors through UCF's The Burnett Honors College. University Honors admission is granted only through The Burnett Honors College, and eligible students must apply as freshmen or as Honors AA transfer students from participating community colleges in all majors and disciplines.

Senior Design Projects of EECS

Intelligent Electric Vehicle Driving System

Home Energy Management System

Low Concentration Thin Films with Solar Tracking

Oil Well Monitoring System

Parking Garage Management System

Solar Golf Cart

Solar Powered Tracker

UCF Solar Farm
DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

Vanessa Baltacioglu  
Chris Chadman  
Shauntice Diaz  
Dr. Samuel Richie – Faculty Advisor  
Sponsored by PowerGrid & TectaAmerica & Progress Energy

Future Uses

- Use in other converted EV’s
- Possible adaptations for use in converted hybrid vehicles
- Data recording even when vehicle is not running in economy mode
- Testing for mileage, performance, and component comparison

Maximum Acceleration

- Acceleration attenuated dynamically as a function of velocity
- Less acceleration for higher velocities
- Optimum acceleration vs. safe/useful acceleration

Specifications

- Increase vehicle range by 5-10%
- Allow data recording for 90 minutes
- Vehicle safety...Individual μC WDT’s, runaway prevention
- Dash-mounted control switch
- EV with power supply of 12-12V batteries (144V total) & 1-12V auxiliary battery

Power Usage

- Minimum power needed to overcome frictional forces at constant velocity
  \[ P = V^2I = 220.46V + 0.87v3 + vma + vng \times \text{SIN}(0) \]
- Power loss due to heat calculated from experimental results
Today it’s a fact that standard cars still run on fossil fuels. Many would like to replace these standard gas or diesel cars with alternative or hybrid cars. There are a growing number of hybrid and fully electric vehicles, as well as electric car conversions driving on the street, some which are owner-converted. The most important aspect for these types of vehicles is how efficient they are. There are many ways of making a car more efficient; regenerative breaking, reducing vehicle weight, and improving aerodynamics. The purpose of this project is to create an intelligent economy-mode system for the fully electric vehicle.

Besides the many projects Progress Energy is sponsoring, this project is one of two projects being sponsored by Power Grid Engineering, an electrical engineering firm who caters to designs of Protection & Control Systems for electric utilities. Power Grid Engineering led us to Tecta America who provided a fully converted electric vehicle, a 2004 Ford Ranger. Tecta America provides commercial roofing service that deals with every type of roofing issue and also provides solar panel installation.

The vehicle provided is fully electric but it is not entirely efficient because of a lack of an economy mode control unit. The unit being designed for this project will take in dynamic vehicle parameters such as speed, acceleration, electrical current, driver input, and motor RPM to regulate vehicle acceleration and flow of current for optimized values. The second part of the project consists of a data recorder, able to record the parameters to a USB drive. After researching the parts already installed in the converted vehicle, we determined it was best to stay with the Warp9 DC electric motor currently installed. The batteries provided in the bed of the truck are twelve, 12-volt dry-cell lead acid batteries. The motors and batteries will be recharged by being able to plug it into a standard wall outlet. To provide accuracy and safety, four PIC microcontrollers will be used in the function of this vehicle. Our goal is to have a power microcontroller that will read all the analog information being sent by the sensors throughout the vehicle; velocity, motor rpm’s, temperature, accelerometer, current, and voltage. This controller will convert these analog inputs into digital values to calculate all the power equations needed to provide the correct voltage to be delivered to from the potentiometer to the motor controller.

After the calculations are computed, the analog-to-digital inputs and the information calculated will be sent to the data controller digitally. The goal of the data microcontroller is to have it store all the information collected from the power controller digitally so can it be saved on a USB drive for further analysis. A file will be created providing an hour worth of data recorded while driving.

Since safety is an objective/goal/requirement, several watchdog timers will be connected to each microcontroller in this system. The purpose of this component is to prevent runaway acceleration. These components will be monitoring a signal from each microcontroller to see if they are running correctly. If not, the timer will send a signal to reset the system. This will prevent a domino effect happening within the system and lead to the driver being clear of any malfunctions. All the microcontrollers and components will be mounted on a PCB board. This board will be connected in series with the entire unit installed in the truck. In order to switch from normal driving mode to economy mode, a button will be located on the dash board for the diver to select economy or normal. This will make the truck more efficient. Our goals for this project are to provide an electric car that can run as well as a gasoline fueled car. In order to obtain this main goal, there are subcategories that need to be reached, such as a car that is also low cost, lightweight, safe, and can change from economy, normal, and performance modes.
Intelligent Electric Vehicle Driving System

DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

Celina Martin
James Kies
Mike Jones
Yazen Ghannam

Dr. Samuel Richie – Faculty Advisor

Sponsored by Progress Energy & PowerGrid

Objectives

- Intelligent Driving System
  - Designed to fit any size electric vehicle
- Reliable Operation
  - Battery Capacity Monitoring
    - Current sensing
    - Voltage sensing
- User Friendly Interface
  - Touch Screen
    - Three modes of operation
      - Performance Mode
      - Normal Mode
      - Economy Mode

Electrical System

Power Supplies

- 12VDC Battery
  - Supplies power to all the electronics
- Battery Management System (BMS)
  - Sensing varies parameters of the Battery Pack
- Solar Panel
  - Charges a Battery

Electrical System

Power Converters

- Power Conversion Block Diagram

UCF Stands For Opportunity®
Greenhouse gasses, such as carbon dioxide and methane, are constantly on the rise as society continues to live the “American dream”. These gasses are responsible for climate changes throughout the world and depleting the ozone layer. Unfortunately the many people that feel a sense of confidence from their standards of living don’t understand the repercussions to come. In this particular case the type of transportation vehicles that are used today have a great influence on the environment of tomorrow. Combustible or gas powered vehicles continually emit these pollutants and destroy the environment for future generations.

Overall it is important to provide society with the same sense of confidence in their transportation vehicles without altering the environment. This senior design project is to create an intelligent driving system for any fully electric vehicle. Any electric transportation device can be equipped with this system and provide society with an efficient, reliable and user-friendly vehicle that doesn’t remove any of the standard features of a combustible car. Therefore people are able to maintain the sense of confidence in their vehicles without influencing the environment. This type of vehicle benefits the environment for both the society of today and those to come. As gas prices are on the rise a fully electric vehicle with this system would eliminate more financial burdens. Furthermore, the United States dependency on other nations for oil importation would decrease, making a more independent and sustainable nation overall.

An original combustible car is transformed to a fully electric vehicle by removing several main components, such as the engine, exhaust pipes, and gas tank. In place of these parts are 12 twelve volt lead-acid batteries and a fully electric DC motor. These two main components in conjunction with a microcontroller allow the vehicle to reach high speeds, similar to a combustible vehicle. In order to make the vehicle more self-sustainable and beneficial to the environment, two 16VDC monocrystalline solar panels are added to charge the auxiliary 12-volt battery that powers the microcontroller along with any D.O.T. required accessories, such as the headlights, tail lights, wipers, turning signals, etc. Furthermore another microcontroller is connected to an LCD display that allows the user to choose from three modes of operation. The performance mode allows the driver to accelerate at the maximum rate to reach high speeds of operation. Whereas the normal mode provides a standard rate of acceleration and curtails the maximum speed to typical city driving limits. The economy mode is the most limited driving mode for power saving. This mode automatically engages after the battery pack capacity decreases to 15% and blocks user selection of the performance or normal modes. The economy setting decreases acceleration rate and maximum driving speeds to withhold as much charge as possible. After reaching the final destination, the vehicle can be charged using a standard 120VAC grounded plug.
DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

Ryan Jones
Zineb Heater
Dennis Kilgore
Dr. Samuel Richie

Sponsored by Progress Energy

Empty House

- You aren’t using most of your house 50% of the time
  - 45+ hours at work (8 hour work day, 1 hour break time)
  - 45+ hours of sleep (7 hours per night)
  - 90+ hours of the 180 hours in a week
- What if you could program your house to ‘shut down’ when you don’t need it?

- 72,542 Billion kWh used in houses in the US
  - 78 Million households in the US using an average of 910 kWh per month
  - 7 Billion kWh wasted by standby power
- 800 Million dollars wasted by consumers per month

Problems

- Power bills only give consumers a look at
  - Monthly power usage
  - Power usage for the entire house
- Standby Power
  - Entertainment systems consume power when off, cable box, gaming system, almost every other modern device
- Research in leading 38 countries shows that Standby power consumes 8 to 12 percent of a home power bill*
  - France – 7%
  - US – 10%
  - Japan – 12%

How you use it

- All that a consumer has to worry about is installing the touch screen
- Plug our box into an outlet, then plug what ever you want to measure into our box
- The data will appear on the touch screen within seconds
- That is all you have to do.

Information Display

- View historic power usage as a graph to see when the appliance is using the most power in a day or week.

*The Economist, 2006
Motivation for this project derives from the need for more effective home energy management. To ensure the sustainability of the planet, we must make a real effort to conserve resources. Our project will assist in this by solving two main problems. First, people often leave electronic appliances on for unnecessary amounts of time when the appliances should be off. Second, wasted standby power leads to extra energy costs that should be avoided as they waste a significant amount of energy.

The goals of this project are to reduce needless power usage in homes with a system that is effective at reducing power use and noninvasive to daily lifestyle in a relatively inexpensive and simple way, without using more power than would be saved.

We will create multiple modules for switching power on and off, as well as monitoring current. A small control unit will be built onto a touch screen display that will monitor usage over the internet. The touch screen display will be the user interface for the system.

A current and voltage measuring circuit will be attached to each outlet in the system. The current and voltage used will be recorded using sensors that we will build and will be sent to the main control device. This main control device will be a touch screen that is able to turn off the flow of power to anything beyond one of the modules. The touch screen will display graphs for power used over time, thereby giving the consumer a visual of the power used at certain times of the day instead of the entire month.

The system will utilize a wireless mesh network so that if one unit is out of reach of the screen, the other units will pass along the data if there is one in range of both the screen and the unit that is out of range. The touch screen will be able to take in the data and perform calculations on the data so that a meaningful value is displayed, not a number in joules or Watts, but Watt hours or kilo Watt hours.
LCTF with Solar Tracking

DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

Amanda Klein
Sean Murphy
Jesse Trawick
Motiur Bhuiyan

Dr. Samuel Richie – Faculty Advisor

Sponsored by Progress Energy

Future of Residential Solar

- It appears thin films can become a less expensive to mass produce alternative to crystalline silicon panels.
- Self-contained, portable modules can target an untapped market of apartment or leased home owners.
- Solar tracking can reduce the space taken up by panels in a residential home, while still keeping efficiency high.
- Interactive power data allows the consumer to connect with renewable energy, increasing its popularity.

Outcomes & Benefits

TOTAL Thin film IPD Market Forecast (in $M)

<table>
<thead>
<tr>
<th>Year</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (in $M)</td>
<td>654</td>
<td>870</td>
<td>631</td>
<td>725</td>
<td>827</td>
<td>1,012</td>
<td>1,176</td>
<td>1,750</td>
</tr>
</tbody>
</table>

CAGR: 16%

Consumer Power Monitoring

- Real time power graphs will be accessible via the internet from any location and any time of day.
- The consumer can monitor how much he saves by using the product.
- By giving the consumer this digital connection to their solar power system, interest in renewable energy increases.
- They can share this information with friends, widening the market through word of mouth.

Design Features

Reflective Solar Trough - Reflects back light that misses top panel.

Single Axis Solar Tracking - Ensures the solar panels are always facing the sun.

Portable Design
Low Concentration Thin Films with Solar Tracking

Solar power is becoming an increasingly popular alternative to traditional sources of energy, with the amount of modules being produced yearly growing exponentially. Within this subset, thin film solar panels, characterized by flexible photovoltaic material, is rapidly gaining more of a share of the market, as shown in Figure 1. This growth trend indicates that there is a large opportunity present in the market of thin film technologies. In addition, the cost of producing a commercial thin film module has recently achieved $0.76/watt, by the company First Solar, setting the bar for production costs lower than ever before.

The prototype that was developed was designed with a certain type of consumer in mind; one who previously did not have access to roof mounted solar technologies. The market being spoken of is that of residents of apartment complexes or leased homes. In this situation, the consumer does not have the ability to perform large scale installation of roof mounted photovoltaics and would require a portable ground based alternative. This is a growing market, with more than 30,000 new unfurnished apartments being completed in the United States in the 2nd quarter of 2010 alone. [3] Tapping into this resource will be key to the success of any company dealing in renewable energy on a large scale.

The product is being designed and prototyped to be a fully functional unit straight off the assembly line, therefore eliminating the need for the consumer to pay for installation or labor, and providing greater ease of use than before. It will be installed on a cart, allowing the buyer to place the module wherever they wish in their yard, as long as there is enough room for a standard size household grill. In addition, the module will have single axis solar tracking installed, ensuring that for any given time of day, the panels are receiving as much sunlight as possible, even in cloudy conditions, increasing total power gains from the device.

In addition, it is planned to provide a web based application where the buyer can access real-time power data for their newly installed panels. This type of feature is well received in today’s market, where mobile phone applications are so commonplace. Using this system, the consumer can see exactly what type of power savings they receive from their panels, no matter the time of day or place.

Thin film solar technologies are growing ever popular in today’s commercial markets. By harnessing this growth and applying it to a new untapped area of leased residences, a company can open up greater opportunities for expansion in the area of renewable resources. Instrumental to this cause will be the ability to provide small scale portable modules with little to no installation costs. Additional features, such as web based power monitoring, will increase the consumer’s connection with the device and increase marketability in a world of mobile phone applications.
DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

Jimit Shah
Kaleb Stankard
Louis Bengton

Dr. Samuel Richie – Faculty Advisor
Dr. Zhihua Qu – Faculty Advisor
Carlos Velez – Advisor

Sponsored by Harris & Progress Energy

GOALS & OBJECTIVES

- Convert wave energy to electrical energy by means of a generator.
- Produce usable energy for the sensors.
- Must be enclosed in a waterproof container.
- Must be suitable for conditions that are present in the Gulf of Mexico.

PRODUCT AND END RESULTS

- An electrical unit was built in order to power up the sensors.
- The product uses wide input and a constant output to the battery.
- It will be suitable in sea and surface conditions.
- The software used in this product will help make the system efficient.
- In the end, this product will be able to produce usable electrical energy.
Oil Well Monitoring System

Since ocean waves provide an intermittent and inconsistent source of energy, a smart energy converter was needed to convert, condition, and supply consistent power to the sensor system. For this purpose an electrical engineering team created a black box electrical unit which was made in four parts: Input Circuit, DC-DC Converter, Battery Charge Controller, and Microcontroller.

According to the specs given by the turbine team, the generator would produce about 0VAC (assuming no wave conditions) to 60VAC. This input was rectified by the Input Circuit via a full wave bridge rectifier. A large smoothing capacitor was then used to convert this full wave rectified signal to a DC signal. The output of this circuit was 0VDC to 56VDC. The DC signal then needed to be stepped down using a buck converter.

A circuit for this purpose was used to convert the input DC voltage to a steady 15.6VDC for the Battery Charge Controller. A few components such as resistance and capacitance in the circuit can easily be changed in order to change the output voltage. It was decided to use a battery in order to provide constant power to the sensors. Hence, to charge the battery, a Battery Charge Controller circuit was made. This circuit ensured a high charging efficiency for the battery under various load conditions.

The 15.6VDC from the DC-DC Converter Circuit was used as an input to the battery charge controller. The output of this circuit was a 13.8VDC which was then used to charge a 12V lead-acid battery.

In order to maximize the power for any kind of wave conditions (heavy or calm), a PIC microcontroller was used to control the load distribution in the circuit for large or small power extraction based on the past history of the input signal. This smart system was designed to optimize overall power production and conversion efficiency. The control hysteresis is defined and controlled using C code which manages the charging conditions. The charging of the battery only takes place between 15VDC and 55VDC for undercharging and overcharging protection. This protects the battery by allowing the input signal to operate within safe parameters for the battery.
Purpose/Goals

- 56,000 students + 7,000 faculty are at UCF
- 45,000 decals sold in 2010–2011
- 22,800 total parking spaces on campus
- 7 garages with 1,300 spaces per garage
  - Turn over 3 times ~ 3–5 thousand cars/garage/day
- 48,000 parking tickets/yr ~ $20–$25/ticket
  - $960,000 – $1,200,000

Current Costs

- The average student drives to UCF at least 64 times a semester
- A car burns .025 gallons every 5 min
- 1.6 gal/semester/driver idling for 5 min
- $3.50/gal * 1.6 gal = $5.60/driver/semester
- 45,000 drivers * $11.20 = $504,000/year
- 162,000 gal/year
The frustration and time commitment for finding a parking spot on the University of Central Florida campus is absurdly high. This system will help students and faculty to quickly and successfully find parking spaces within garages by calculating how full each garage is. As senior students, our group is tired of driving around in parking garages only to find them full and having to wait for someone to leave and “stalk” them in order to take their spot; which too often results in being late for class. The end product will be a fully automatic and operational garage management system with live video feed and a website to simplify conveying the information to the drivers.

It is our hope that this will also significantly reduce congestion inside the garages, making it easier to navigate as well as decreasing the number of accidents. The reduction of accidents will cause less congestion as well, creating a cyclic event.

The Remote Parking Garage Management System will use several cameras to detect whether spots are empty or contain a vehicle. Our system will be scaled down to half of one floor for financial reasons. This change does not affect the difficulty of the project, just the cost in setting it up. The camera data will be sent to a laptop where the detection algorithm will interpret the data the cameras send to it to determine whether or not there is a vehicle within any given location, and then count the vehicles to determine the garage’s current capacity. The laptop will then update the website and the programmable LED sign. The website can be accessed publicly on any web browser, and will contain live feed as well as the number of available parking spaces for each garage. The programmable sign will display how many empty parking spaces are in each half of the garage.

The power for the electronics will be provided by a mix of solar panels and grid power. The solar panels will be placed along the side of the garage to extend sun visibility as long as possible. The solar panel will connect to a charge controller and battery that will provide several hours of power regardless of the panel output. The Inverter is a modified sine wave inverter that uses a microcontroller incorporated with a battery meter, current sensor, and LCD display. The grid power will be utilized when the battery power level reaches nine volts, triggering an automatic transfer switch ensuring the system always has a steady source of power.
DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

Solar Golf Cart

David Yeung
Nick Paperno
Patrick Taylor
Andrew Bridges

Dr. Samuel Richie – Faculty Advisor
Sponsored by Progress Energy

Savings
- Using an average of $0.12 per kilowatt per hour.
- Using an average of 30 golf carts per golf course

<table>
<thead>
<tr>
<th>How many times it will be charged</th>
<th>Savings per cart in a Year</th>
<th>Savings per golf course in a Year (30 golf carts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Once A Week</td>
<td>$497.32</td>
<td>$14,919.60</td>
</tr>
<tr>
<td>Twice A Week</td>
<td>$994.64</td>
<td>$29,839.20</td>
</tr>
<tr>
<td>Every Other Day</td>
<td>$1,255.20</td>
<td>$37,656.00</td>
</tr>
<tr>
<td>Every Day</td>
<td>$1,590.40</td>
<td>$47,712.00</td>
</tr>
</tbody>
</table>

Monitoring
- Various sensors will be used to monitor the workings of the golf cart.
- The driver will be able to control the modes of operation using a switch located near the ignition.
- The mode and measurements taken by the sensors will be displayed on the screen for the driver to see.

Display Screen
- Use of displays in vehicles is becoming more popular.
  - Chevy Volt
  - Toyota Pruis
  - Nissan Leaf
- Programmable LCD module is used to:
  - Read information from sensors
  - Display information on the screen
- Will show the following information:
  - Current mode of operation
  - Speed
  - Charge remaining as a time and percentage
  - Distance travelled

Speed Control
- Resistive speed control
- Pulse Width Modulated (PWM) Signal

Display from Chevy Volt
The goal of this project is to make an energy efficient electric golf cart. The motivation of this project is based off designing a more efficient golf cart. The golf cart will have 3 different modes of operation: efficient, high performance and power saving. Efficient mode will be the standard mode of operation. The goal of efficient mode is to be a balance between high performance mode and power saving mode. The indirect relationship between power and efficiency is the reason multiple modes are necessary. In high performance mode, the golf cart is not as concerned with energy consumption.

Instead, the golf cart will pull more energy to accelerate faster and have a higher top speed. Efficient mode, on the other hand, will focus on conserving energy to maximize the time until the golf cart runs out of energy. This conservation will result in a lower acceleration and a lower top speed. Power saving mode is automatically turned on when the golf cart has less than 15 percent of its charge remaining. In power saving mode, power is greatly reduced to maximize efficiency.

The electric power for the golf cart will come from batteries and a solar panel. The batteries can be charged from a wall outlet and by the solar panel. The batteries will be able to charge in a timely manner and hold their charge long enough to power the golf cart for a reasonable time and distance. There will be a simple system to test the batteries to see if one has become defective. There will be a touch screen in the golf cart that will control what mode it is in and display information. It will accurately display the current mode of operation, speed, charge remaining, and estimated time remaining.
Solar Powered Tracker

DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

Dijon Gumbs
James Lillie
Kaniel Martin

Dr. Samuel Richie – Faculty Advisor
Sponsored By Progress Energy

Benefits
- Utilize Solar Energy
- Use One of Florida's Biggest Renewable Resources
- Charges 12V Batteries
- Saves Electric Bill Costs
- Powers a Nintendo Wii

S.E.G.S. Prototype

Design Flowchart

S.E.G.S. Monitoring

UCF Stands For Opportunity®
Solar Powered Tracker

Our main motivation for our design procedure in this project is to emphasize the benefits of being able to conserve energy through the usage of one type of renewable source, solar power. Our project will involve using solar panels to convert sunlight into energy to power a Nintendo Wii game console. This method of charging a console will allow the consumer to have power delivered to them even in the case of an electrical power outage. The reason why this project is important is because it will steer us into a new direction of harnessing renewable power sources that will help us to become more independent of traditional forms of power (i.e. electrical outlets, generators).

The main approach towards the design of our project was based off of comparing past projects and seeing what we can do to make them more cost-efficient, and more unique. The Nintendo Wii system that we are using only generates around 16-18 watts which is ideal in contrast to the Xbox 360, which generates around 180 watts. We saw through these old projects that those designs were not really cost efficient or saving power, but they consumed a lot of power which was the problem that was meant to be solved. We made more progress solving our problem with this project through the use of testing procedures, especially in the domain of solar panel testing and the method of using an inverter to charge the Nintendo Wii console. The important variables needed to be watched over were the voltage maintenance of the photoresistors and the brightness levels being revealed so that the design will rotate in the correct direction for the most amount of sunlight needed to charge the device.

For our design we decided to combine the best of both worlds in terms of actuation; linear and stepper motors. Many of the solar trackers use pairs of linear actuators, servos or stepper motors but not normally combined. We found that using a linear actuator for 90 degree tilt and a stepper motor for 360 degrees rotation we can obtain almost every angle on a 3-D plane. To control these motors we implemented a microcontroller that takes readings from an array of photo diodes. These diodes will be placed in the shade such that when the panels are directly facing the sun all the diodes are in the shade. If the sun is coming from an angle it will hit the diodes on one side and not the other. When the light hits a diode and not the other the microcontroller will know which direction to move. Finally these panels will be used to charge batteries and to ultimately power a Nintendo Wii. To do this we will be taking the power from the panels, send it through a DC/DC converter, and then through a power inverter that will supply power for the Wii.

In conclusion, this idea can potentially change the world in a slightly different way than we envisioned it. Due to the increase in changes to different renewable sources, such as the electric car or the solar powered station, we can see the world moving towards being independent in the alternative energy area. This path that we have taken will be useful to our learning for future opportunities and for other consumers as well.
A solar farm that will help the University of Central Florida meet its commitment of becoming climate neutral in the future is among 22 innovative “green” projects that were showcased at the third-annual Progress Energy Senior Design Symposium Friday, April 8, 2011.

The symposium was held in UCF’s Student Union. Vincent Dolan, president and CEO of Progress Energy Florida, delivered the symposium welcome.

Senior undergraduate students in all departments of UCF’s College of Engineering and Computer Science (CECS) designed the projects which all focus on renewable and sustainable energy.

“In this era of global uncertainty, the world needs engineers to continue creating innovative alternative energy solutions,” said Marwan Simaan, dean of UCF’s College of Engineering and Computer Science. “The Senior Design Symposium helps prepare our students to become future engineering leaders with skills that allow them to tackle the world’s energy challenges.”

The UCF solar farm, initiated by UCF’s Department of Sustainability and Energy Management, involves three multi-disciplinary teams of CECS students. Mechanical Engineering students have created a mounting system that provides easy installation of solar panels to reduce the labor costs associated with constructing a solar farm. The mounting system also holds panels at an angle to maximize sun exposure. Industrial Engineering students are providing a cost-benefits analysis and Electrical Engineering students have created a system to monitor energy production and flow.
As the cost of energy continues rise and the University of Central Florida’s population continues to grow, a safer alternative of energy production than fossil fuels is becoming ever more important. One safe substitute to fossil fuel energy production that UCF is exploring right now is the idea of installing photovoltaic farms in and around the campus to alleviate some of the burden that the university feels from purchasing all of its energy. This research is an investigation into how the individual monitoring of the solar panels on these electric farms can help to increase the overall efficiency of the farms while reducing the universities overall carbon footprint on the local environment.

To accomplish the task of making these photovoltaic farms as profitable and efficient as possible for the university, an array of eleven panels will be monitored by a self-sustaining panel monitoring system. The data collected by the monitoring system will be every individual panel’s output voltage, output current, and temperature. This data will be collected and sent wirelessly to be stored in a database for future analysis. These quantities are desirable to measure and record for several reasons. In a large scale farm that could consist of thousands of panels, that are all electrically connected, trouble shooting the system to see which panel is malfunctioning could be a daunting and expensive task. This data will provide valuable feedback about how much energy each panel is producing as well as the entire farm. With this knowledge many educated decisions can be made pertaining to the solar farm. These decisions can range from what type of solar panels are best suited for the application UCF wants to pursue, what orientation of the solar panels is best suited for UCF’s location, as well as the most efficient way for these farms to be operated and connected to the grid. The data can also be used to troubleshoot the system by comparing every panels output against another quickly identifying outliers. By monitoring the solar panels individually, the down time of the system due to repairs can be minimized, unlike other solar farms which need to be shut down for extended periods of time to troubleshoot and repair.
DEPARTMENT OF INDUSTRIAL ENGINEERING & MANAGEMENT SYSTEMS

IEMS Department has grown in stature through our commitment to excellence in education, cutting-edge research, and service. The areas of expertise of our talented faculty include modeling and simulation, quality engineering, project and program management, operations research, e-design, human factors/ergonomics, safety engineering, human systems integration, and systems engineering.

Our ABET-accredited undergraduate program prepares students with the best fundamental knowledge of the IE discipline. Our IEMS graduate curriculum is structured to allow students to develop desired expertise in the various areas of industrial engineering, engineering management, and systems engineering, and to tailor their programs of study to match their personal interests.

Our Department benefits from extensive research facilities and modern laboratories that support our academic and research programs.

Senior Design Projects of EECS

UCF Solar Farm
DEPARTMENT OF INDUSTRIAL ENGINEERING and MANAGEMENT SYSTEMS

Amanda Longman
Joshua MacNaughton
Andrew Wolodkiewicz

Dr. Christopher Geiger – Faculty Advisor
Dr. William Thompson – Faculty Advisor
Dr. Samuel Richie – Faculty Advisor

Sponsored by Department of Sustainability and Energy Management & Progress Energy

Solar Farm Project Goals

- Conduct a feasibility study of constructing a 3-MW solar farm on the UCF main campus
- 3 MW will supply approximately 15% of the peak energy demand on the main campus (Norvell, 2010)
- Project involves constructing design prototype
  - Multidiscipline senior design team (MEs, EEs, and IEs)

Forecast Analysis

3-MW Design Benefits

Each year, the 3 MW Solar Farm Can Eliminate:

- Greenhouse gas emissions from approximately 623 vehicles
- CO₂ emissions from the electricity use of 386 homes
- CO₂ emissions from 132,487 propane cylinders used for home barbecues
- $322,110/year from UCF energy bill

Forecast Analysis

Transitioning from 0.003-MW Design to 3-MW Design

- Panel requirements:
  - 11 panels to 12,507 panels
  - This requires 1,137 arrays
  - Space is necessary between rows
- Land requirements:
  - 240 sq ft to 653,400 sq ft
  - 0.006 acres to 15 acres
  - More than 11 football fields

Forecast Analysis

Prototype Benefits

Each year, the prototype (0.003 MW) can:

- Take 0.548 vehicles off the road
- Eliminate CO₂ emissions from 0.339 homes
- Eliminate CO₂ emissions from 117 propane cylinders used for home barbecues
- Save UCF $283.30/year

*Obtained from http://www.epa.gov/cleanenergy/energysources/calculator/air/outputs, April 4, 2011*
UCF Solar Farm

The University of Central Florida (UCF) is contemplating the installation of a solar panel farm. UCF is interested in this project because the University has signed the American College and University Presidents’ Climate Commitment, a pledge to become climate neutral. UCF aims to have a net zero carbon footprint by the year 2050. The addition of a 3-MW solar farm would support this commitment by providing 15% of the power for the main campus from a renewable energy source. This project investigates the feasibility of the solar farm and identifies the solar farm’s potential benefits and risks.

Three engineering senior design teams, each from different engineering disciplines, collaboratively created the design of the 3-MW solar farm. The disciplines of the senior design teams included electrical engineering, industrial engineering, and mechanical engineering. The three engineering disciplines worked together to develop a prototype array of solar panels. The industrial engineering team selected the most cost-effective solar panel. The mechanical engineering team designed the mounting system, and the electrical engineering team designed a power monitoring system. This prototype serves as the base for the entire system analysis. The industrial engineers performed a total system cost analysis.

The industrial engineers provided a detailed cost analysis of the proposed solar farm design. The analysis includes the life-cycle costs and full payback period, along with a detailed summary of investment of the components, sub-assemblies, and materials. This analysis begins with an assessment of the student design of a prototype of the proposed solar energy system. Then, a comparison is made against project cost estimates from multiple private design firms.

UCF has already identified approximately three acres on the main campus which are available for the construction of the solar farm. This space of land may be used to generate 0.691 MW. A solar farm capable of providing 3 MW of power requires 15 acres. Using the student design, the solar farm will have an initial cost of approximately $15M. The University may alternatively choose to hire a contractor to design and construct the solar farm. This option is expected to cost the University between $10M and $16.5M. The solar farm will result in more than $300,000 in tax-free savings to the University each year and its annual carbon emission reduction is equivalent to removing 623 passenger vehicles from the roads.

The multidisciplinary team has designed and constructed a prototype solar panel array that may be used to help UCF meet the goals of the Presidents’ Climate Commitment. The solar farm represents a large financial investment, but it is expected to have a strong positive effect on the community surrounding UCF. The University can produce renewable energy on-campus in a clean, quiet, and environmentally friendly manner by moving forward with the solar farm project.
Presents:
The 4th Annual Senior Design Symposium
On Renewable & Sustainable Energy

Friday, April 13, 2012
8:00 AM – 1:00 PM
UCF Student Union
Pegasus Ballroom

Keynote Speaker
Dr. Dan Arvizu
Director, U.S. Department of Energy
National Renewable Energy Laboratory

After more than three decades of professional engagement in the clean energy field, Dr. Arvizu has become one of the world's leading experts on renewable energy and sustainable energy. He frequently engages with national leaders in Congress, the Administration, academia, non-governmental organizations, and industry. http://www.nrel.gov/director/biography.html

Symposium Sponsored By
Progress Energy
Scan to view recorded symposium.