

FINAL SCIENTIFIC/TECHNICAL REPORT

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DOE Award Number DE-EE-0000309

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Project Period of Performance: November 1, 2009 through March 1, 2015

Total Project Cost: **\$195,512.50**

(\$97,756.25 Orange County/\$97,756.25 DOE/GO)

Title:

Orange County Government Solar Demonstration and Research Facility

Executive Summary

Orange County Government located in Orlando Florida completed the construction of a 20 kilowatt Solar Demonstration and Research Facility in March 2015. The system was constructed at the Orange County/University of Florida Cooperative Extension Center whose electric service address is 6021 South Conway Road, Orlando, Florida 32802. The Orange County/University of Florida Cooperative Extension Center receives a high volume of visitors from the greater Orlando area and is within five 5 miles of the Orlando International Airport that currently receives 60 million plus visitors annually. The Orange County/University of Florida Cooperative Extension Center's educational programs are focused on issues such as sustainable agriculture, competitiveness in world markets, natural resource conservation, energy conservation, food safety, child and family development, consumer credit counseling, and youth development.

The Orange County Solar Demonstration and Research Facility is comprised of 72 polycrystalline photovoltaic modules and 3 inverters which convert direct current from the solar panels to alternating current electricity. Each module produces 270 watts of direct current power, for a total canopy production of just under 20,000 watts. The solar modules were installed with a fixed tilt of 5 degrees and face south, toward the equator to maximize the amount of sunlight the solar array captures. Each year, the electricity generated by the solar array will help eliminate 20 metric tons of carbon dioxide emissions as well as provide covered vehicle parking for staff and visitors at the Orange County/University of Florida Cooperative Extension Center.

The solar array is expected to generate 27,000 kilowatt hours of electricity annually; equating to an estimated \$266 savings in the monthly electric bill, or \$3,180 annually for the Orange County/University of Florida Cooperative Extension Center. In addition to reducing the electric bill, Orange County will participate in a Solar Photovoltaic Production Incentive rebate incentive offered by the local utility, Orlando Utility Commission, which provided a meter which measures the amount of power produced by the solar array. The utility company's rebate incentive will pay Orange County \$0.05 per kilowatt hour for the power that is produced. The incentive is provided in addition to Net Metering benefits, which is an effort to promote the use of clean, renewable energy on the electric grid.

The Solar Demonstration and Research Facility also serves as an educational tool to the public and visitors of the Center. The solar array is tied directly into a data logger that provides real time power generation accessible for public viewing on an interactive kiosk located in the Orange County/University of Florida Cooperative Extension Center's lobby. Visitors at the center can view the "real time" power generation, cost savings and environmental benefits of the solar array system. In addition an educational flyer was developed and is available in the Orange County Education Center's main lobby, marketed on Orange County's social media websites and available for download online.

As a benefit to promoting sustainability, the Solar Demonstration and Research Facility is also located near an existing level 1/level 2 (110/240 volts) electric vehicle charging station owned and operated by the local utility company, Orlando Utilities Commission; public users of the charging station are charged \$0.13 per kilowatt hour to charge their electric vehicles.

Additionally, in June 2015 Orange County plans to complete the installation of a dual level 2 (240 volts) charging station under the Solar Demonstration and Research Facility solar array canopy to assist with stimulating and advancing the adoption of increased electrical vehicle usage and ownership in Orange County. By providing additional electrical generation and infrastructure, residents and visitors of the Orange County/University of Florida Cooperative Extension Center will learn to adopt personal behaviors to make more sustainable choices by using applications of renewable energy technologies that are readily accessible as well as assist in their participation of the reduction of greenhouse gas emissions.

The addition of the new Photovoltaic Solar Demonstration and Research Facility will have direct impact and has advanced the Orange County/University of Florida Cooperative Extension Center's mission of extending, educating and providing research-based information to residents and visitors of Orange County by demonstrating the application of renewable energy technology combined with energy efficiency measures; resulting in reduced energy costs ultimately assisting Orange County move towards the goal of greater energy independence and climate protection. Orange County completed this project to help stimulate market demand that will advance the commercialization and the widespread application and use of renewable energy technologies in the state of Florida.

Project Overview and Accomplishments

Orange County is located in the State of Florida and is most popularly referred to as Orlando. The greater Orlando area has a current population base of 1,225,267 and in 2015 was the first destination to surpass 60 million visitors. The purpose of this grant was to construct one covered photovoltaic system, totaling 20 kilowatts. The projected included the design, purchase, and installation of the photovoltaic system to offset the Orange County/University of Florida Cooperative Extension Center's electrical use as well as serve as an educational outreach component to educate visitors of the Extension Center about greenhouse gas emission reduction strategies, solar energy, electric vehicles, other renewable energy technologies and energy efficiency. An educational flyer was created which included details of the photovoltaic system and is readily available in the Extension Center's main lobby.

Orange County Florida completed the construction of a 20 kilowatt Solar Demonstration and Research Facility in March 2015. The system was constructed at the Orange County/University of Florida Cooperative Extension Center whose electric service address is 6021 South Conway Road, Orlando, Florida 32802. The Solar Demonstration and Research Facility is comprised of 72 polycrystalline photovoltaic modules and 3 inverters which convert direct current from the solar panels to alternating current electricity. Each module produces 270 watts of direct current power, for a total canopy production of just under 20,000 watts. The solar modules were installed with a fixed tilt of 5 degrees and face south, toward the equator to maximize the amount of sunlight captures. Each year, the electricity generated by the solar array will help eliminate 20 metric tons of carbon dioxide emissions as well as provide covered parking for staff and visitors vehicles.

The solar array is expected to generate 27,000 kilowatt hours of electricity annually equating to an estimated \$266 savings in the monthly electric bill, or \$3,180 annually for the Orange County/University of Florida Cooperative Extension Center. In addition to reducing the electric bill for the Extension Center, Orange County's solar array also takes advantage of a rebate incentive offered by the local utility, Orlando Utility Commission, which provided a meter that measures the amount of power produced by the solar array. The local utility company's Solar Photovoltaic Production Incentive will pay Orange County \$0.05 per kilowatt hour for the power that is produced by the solar array. This incentive is provided in addition to Net Metering benefits, which is an effort to promote the use of clean, renewable energy on the electric grid. The Photovoltaic Solar Demonstration and Research Facility also serves an educational tool to the public; the solar array is tied directly into a data logger that provides real time power generation accessible for public viewing on an interactive kiosk located in the Orange County/University of Florida Cooperative Extension Center's lobby where visitors can review "real time" power generation, cost savings and environmental benefits of the system. Site commissioning with the software program was delayed due to Internal Security Software issues within Orange County that needed to be resolved, therefore the "real time" capture of the production data for the solar array using the software program commenced on May 1, 2015. In addition an educational flyer was developed and is available in the Orange County Education Center's main lobby.

The project completed under this grant award assisted Orange County in demonstrating leadership by installing the application of a renewable energy technology combined with energy efficiency measures; resulting in reduced energy costs for the Orange County University of Florida Cooperative Extension Center, and helping Orange County citizens and visitors move towards the goals of greater energy independence and climate protection. The addition of the new Solar Demonstration and Research Facility has advanced the Orange County/University of Florida Cooperative Extension Center's mission of extending, educating and providing research-based information to residents and visitors of Orange County by demonstrating the application of renewable energy technology combined with energy efficiency measures; resulting in reduced energy costs, and helping Orange County move towards the goal of greater energy independence and climate protection. In 2014, the Orange County Cooperative Extension Center hosted nearly 10,800 visitors to their on-site Exploration Gardens plus 12,686 walk-in visitors to their office plant clinic and other services. The Education Center held 2,217 educational events that were attended by 46,434 adults and youth, but about half of those events occurred off-site. Based on the visitation numbers in 2014 the Orange County Cooperative Extension Center Education is a vital partner to Orange County's continued outreach and education efforts concerning renewable energy technologies and greenhouse gas emission reduction well in the current 2015 year and future years of operation of the solar array to the future visitors of the Center which help stimulate market demand that will continue to advance the commercialization and the widespread application and use of renewable energy technologies in Orange County and the state of Florida.

The project period performance date for this grant was November 1, 2009 through March 1, 2015. The Final Project costs to complete the project as reported in the FINAL SF 425 were \$195,512.50 (50% recipient cost share was satisfied as required by grant terms and conditions).

Comparison of Accomplishments with Project Goals & Objectives:

Project Goals & Objectives

- Construct one photovoltaic system, totaling 20 kilowatts at the Orange County/University of Florida Cooperative Extension Center.
- Educate the public regarding greenhouse gas emission reduction strategies, solar energy, electric vehicles, other renewable energy technologies and energy efficiency.

Accomplishments

- Installed one 20 kilowatt photovoltaic system solar array at the Orange County/University of Florida Cooperative Extension Center.
- Participate in a Solar Photovoltaic Production Incentive program where the local utility company will pay Orange County \$0.05 per kilowatt hour for the power that is produced by the solar array.
- Participate in Net Metering benefits at the Orange County/University of Florida Cooperative Extension Center, which is an effort to promote the use of clean, renewable energy on the electric grid.
- Generate electrical savings; the solar array is expected to generate 27,000 kilowatt hours of electricity annually equating to an estimated \$266 savings in the monthly electric bill, or \$3,180 annually for the Orange County/University of Florida Cooperative Extension Center.
- Installed an interactive kiosk located in the Orange County/University of Florida Cooperative Extension Center's lobby where visitors can review "real time" power generation, cost savings and environmental benefits of the system.
- Advanced the Orange County/University of Florida Cooperative Extension Center's mission of extending, educating and providing research-based information to residents and visitors of Orange County by demonstrating the application of renewable energy technology combined with energy efficiency measures; resulting in reduced energy costs, and helping Orange County move towards the goal of greater energy independence and climate protection and greenhouse gas reduction.
- Developed an educational brochure about the solar canopy for distribution in the lobby of the Extension Center, marketed on Orange County's social media websites and available for download online. Downloadable flyer is available on the following websites:

University of Florida IFAS Extension: <http://orange.ifas.ufl.edu/>

Air Quality: www.orangecountyfl.net/Environment/AirQualityManagement.aspx

Sustainability:

www.orangecountyfl.net/OpenGovernment/Sustainability/NaturalResources.aspx

Central Florida Clean Cities Coalition: <http://centralfloridacleancities.com/>

Get Ready Central Florida (Electric Transportation): www.PlugAndGoNow.com

Future Directions

- Orange County plans to install a dual level 2 (240 volts) charging station under the existing Solar Demonstration and Research Facility solar array canopy to assist with stimulating and advancing the accessibility to electric charging stations that increase electrical vehicle usage and ownership in Orange County. By providing the additional electrical generation and infrastructure, residents and visitors will learn to adopt personal behaviors to make more sustainable choices by using applications of renewable energy technologies that are readily accessible as well as assist in their participation of the reduction of greenhouse gas emissions.

Summary of Project Activities during Funding Period

The project was originally awarded and approved to install two PV systems, totaling 50-kilowatts; a 25-kilowatt covered parking facility, with the possibility of an electric car charging station and the second system a 25-kW ground-mounted PV system with a storm water runoff component. Both systems were to be constructed at the Orange County Cooperative Extension Center which is a source of educational resources and has access to the latest research and information on more than 2,000 subjects of interest. The project included the design, purchase, and installation of the PV systems as well as an educational outreach component. The estimated original start date was spring 2010; construction by spring 2011 and project completion by winter 2011.

Orange County issued a Request for Information on July 26, 2010 and received letters of interest from four companies in August 2010. Design work was completed for the two PV systems in September 2011 with the total construction cost estimated at \$338,086. In May 2012, Orange County issued a Request for Proposal solicitation Y12-817-SB for “Construction of Cooperative Extension Photovoltaic Exhibit,” which also required the contractor to provide the 50% cost share defined as the amount of resources (e.g. cash, labor hours, equipment, etc.) expressed as a financial value that the contractor must contribute as part of the project in exchange for the environmental attributes. Unfortunately, Orange County received no responses to the RFP solicitation, which may have been due in part to changes in the perceived value of the environmental attributes. Since the initial procurement strategy was not successful, Orange County considered using a power purchase agreement contract with the Orlando Utilities Commission to provide the required match. Orange County was well into negotiations with Orlando Utilities Commission for a power purchase agreement at the Orange County Convention Center, which we thought could serve as a model for another power purchase agreement at the Cooperative Extension. However, negotiations for the PPA at the Cooperative Extension dragged on from late 2012 to mid-2013 before eventually breaking down.

In October 2013, Orange County obtained a revised cost estimate of probable construction costs and cursory design review of the two photovoltaic structures based on the design work conducted in 2011. This additional and independent review of information helped determined that Orange County did not have the necessary funding for the required coast match for building both structures. After consulting with the Florida Solar Energy Center, it was determined that a system with a modular design could be much less expensive.

In February 2014, Orange County discussed the issue with DOE and proposed to down scope the original size of the project and obtain a revised cost estimates and submitted a revised Statement of Project Objectives for approval.

In May 2014, Orange County issued a design/build solicitation for a modular design 20-kilowatts solar photovoltaic covered parking structure. After receiving bids in May 2014, Orange County confirmed that we had the resources to pay the required grant match for permitting, design, construction, and commissioning of one 20kw ground mounted photovoltaic covered parking structure.

In August 2014, Orange County completed the design build contract selection and awarded a contract to construct the 20 kilowatt photovoltaic covered parking structure at the Orange County/University of Florida Cooperative Extension Center. Preliminary activities for the design process and construction process included a kick-off meeting to discuss project schedule and master plan approvals, final design approvals and permitting submittal.

In September 2014, submittal for the project permit occurred and was issued a City of Orlando's Building Permit (BLD2014-06765). The submittal of the permit was made two to three weeks later than our project schedule plans. Delays were cause due to an underground conflict that the contractor's engineers found after they were provided As-Built plans for the existing parking lot/building. The conflict consisted of a sewer force main which conflicted with one of the three proposed foundation footers for the solar carport; which would require a reroute of the sewer. However, due the wind loads on the PV canopy, the City of Orlando permitting required that the photovoltaic structure needed to be built with four footers rather than the proposed three. Revisions were incorporated per the City's request which also indicated there was no need to reroute the sewer force main because of the new placement of the four footers; the permit was approved October 1, 2014. Additionally in September 2014, a sign was designed, erected and installed indicating the future home of the 20 kilowatt Solar photovoltaic Carport which assisted in marketing the project to an audience of approximately 5,000 visitors of the Orange County/University of Florida Cooperative Extension Center during the annual Fall Plant and Garden Festival held on September 20, 2014.



During October 2014, the foundation system was installed and inspected. The racking structure was procured and began to erect and install the photovoltaic structure and canopy.



From November 2014 to March 2015, project work continued with asphalt repairs, restriping of parking lot, sod repairs, and exterior electrical were completed, obtained final electrical inspection, local utility company setting and installing the meter. The system was then tied to a monitoring system and kiosk panel display located in the Orange County/ University of Florida Cooperative Extension Center that provides the visitors of the Center “real time” power generation, cost savings and environmental benefits of the system. In addition an educational flyer was developed and is available in the Orange County Education Center’s main lobby.



Products Developed under the Award & Technology Transfer Activities:

Earlier this year, after several inquiries about the solar canopy from residents and business owners visiting the Orange County/University of Florida Cooperative Education Center the County developed a flyer to explain the 20 kW Solar Carport (see link below):

http://ocextension.ifas.ufl.edu/oces_pdffiles/SolarPVFlyer.pdf



Converting Sunshine to Electricity with a Solar Photovoltaic Canopy

UF IFAS Extension UNIVERSITY OF FLORIDA

What maintenance is required for Photovoltaic & Solar Thermal systems?

Photovoltaic and other types of solar systems typically do not require maintenance other than periodic cleaning of the panels. PV panel life is typically 25 years. Solar thermal systems, because they heat water or a heating fluid, may need valves replaced every 3-5 years and storage tanks replaced every 10 years. Collector life is usually in excess of 15 years. This assumes "good" water quality is used in your system, and it was properly installed.

How much energy do 20 kW solar arrays generate and how much money is saved?

The 20kW photovoltaic array is rated to generate 27,000 kWh of electricity annually. This equates to about a \$266 savings in the monthly electric bill, or \$3,180 annually. Each year, the electricity generated has the capacity to power nearly 3 homes.

What is Net Metering?

Net Metering is for electric customers who generate their own electricity. This technology allows for the flow of electricity both to and from the customer - typically through a single, bi-directional meter. When a customer's generation exceeds the customer's use, electricity from the customer flows back to the grid, offsetting electricity consumed by the customer at a different time during the same billing cycle.

In effect, the customer uses excess generation to offset electricity that the customer otherwise would have to purchase at the utility's full retail rate. Net metering is required by law in most U.S. states, but state policies vary widely.

How Do Solar Photovoltaic Systems Work?

Photovoltaics (PV) are arrays of solar cells that convert light into electricity. PV technology has improved in quality and declined in price since first introduced, due to a steady increase in sales volume. Most residents and business owners start small, since PV can be added in modular increments as your energy needs and investment capabilities grow.

It is important to focus on reducing your overall energy use through energy efficiency and solar water heating prior to sizing a solar PV system for your home or business.

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gosolarflorida.org

For more information about Solar Energy contact the Orange County Environmental Protection Division at (407) 836-1400 or www.OCFP.net/EPD.
For information about Orange County's UF IFAS Extension Programs go to: <http://orange.ifas.ufl.edu>

Orange County has been a partner with the University of Florida's Cooperative Extension Service since 1914. The 20 kilowatt system was installed at this location due to its university ties and the heavy residential and commercial traffic it receives. This facility offers a myriad of classes both for recreation, as well as continuing education units of businesses: <http://orange.ifas.ufl.edu/>. Subjects such as Agriculture, Family & Consumer Sciences, Landscaping and Sustainability are taught on a routine basis. They also have a Plant Clinic where visitors routinely drop-in unannounced to have insects, or plants identified and to learn about sustainable practices for their home or business. Extension agents hold workshops throughout the community for those who cannot attend classes at their facility. Educational Information about the 20 kW solar array is available in the lobby and as a handout provided by Extension agents. Other websites to view the downloadable educational flyer are available on the following websites:

University of Florida IFAS Extension: <http://orange.ifas.ufl.edu/>

Air Quality: www.orangecountyfl.net/Environment/AirQualityManagement.aspx

Sustainability: www.orangecountyfl.net/OpenGovernment/Sustainability/NaturalResources.aspx

Central Florida Clean Cities Coalition: <http://centralfloridacleancities.com/>

Get Ready Central Florida (Electric Transportation): www.PlugAndGoNow.com