

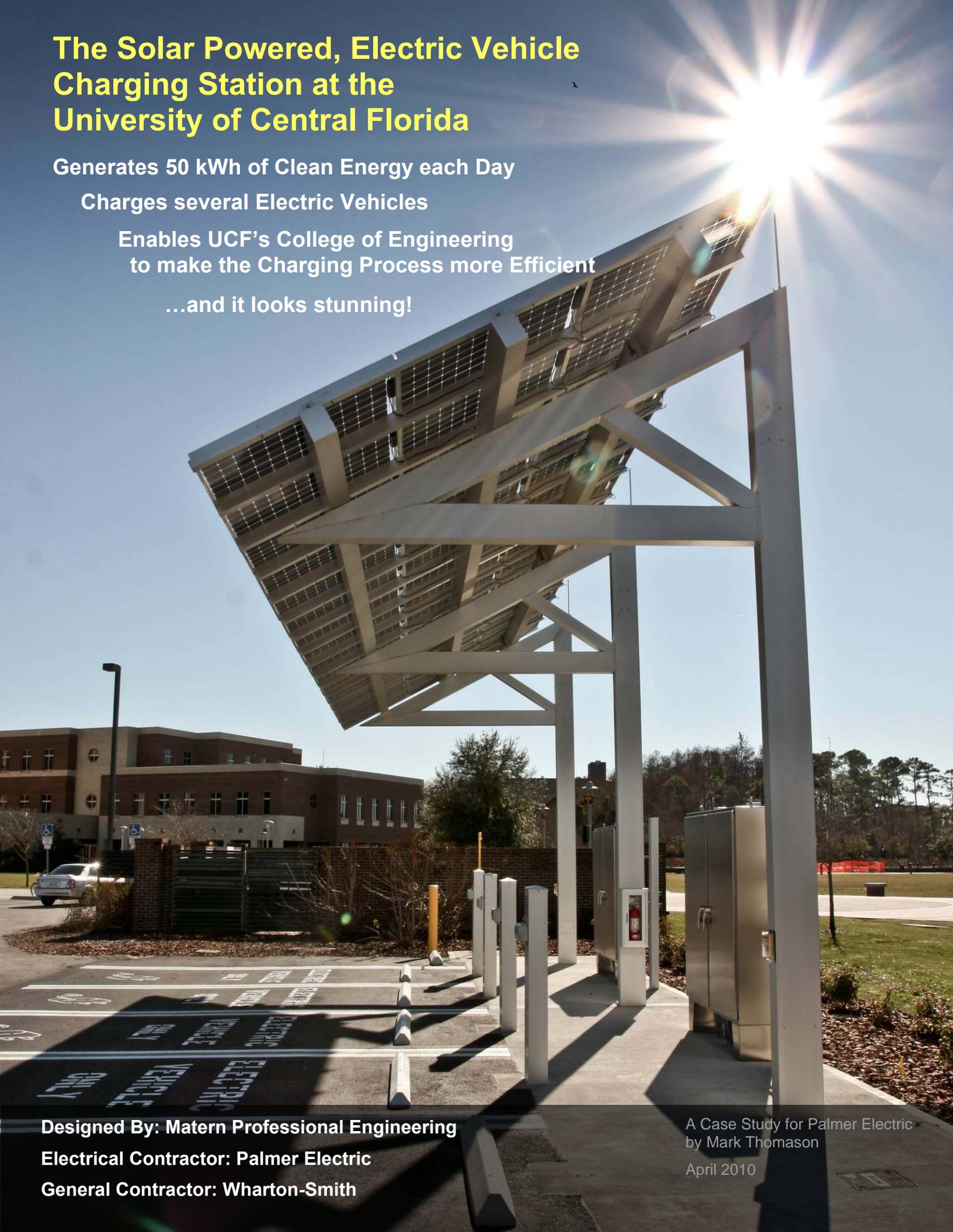
The Solar Powered, Electric Vehicle Charging Station at the University of Central Florida

Generates 50 kWh of Clean Energy each Day

Charges several Electric Vehicles

Enables UCF's College of Engineering
to make the Charging Process more Efficient

...and it looks stunning!



Designed By: Matern Professional Engineering

Electrical Contractor: Palmer Electric

General Contractor: Wharton-Smith

A Case Study for Palmer Electric
by Mark Thomason

April 2010

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Why is a Solar Charging Station a good idea?

There is a 99% probability that you will see two new technologies become VERY popular in the next 5 years...

- **Photovoltaic Panels (PV or Solar Panels)** – which make Direct Current (DC) electricity
- **Electric Vehicles (EV)** – which use DC that is stored in batteries

Why?

Both of these technologies are key players in our efforts to solve two important problems our nation is facing:

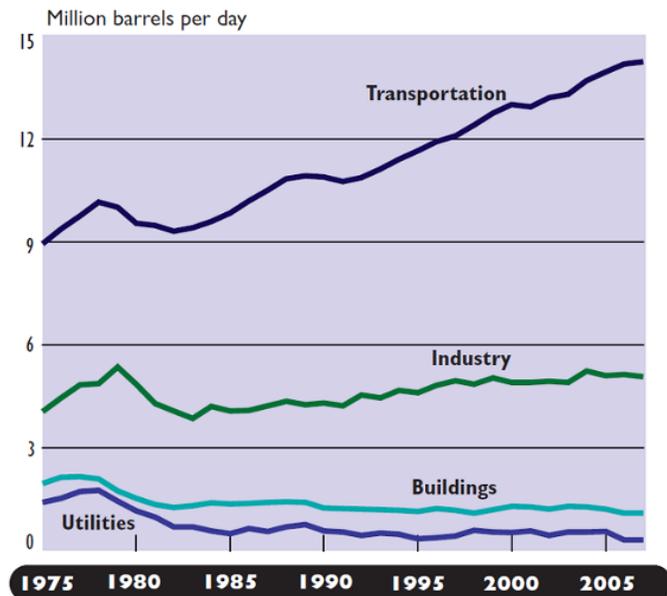
- **Reducing dependence on fossil fuels.** The US currently uses over 60% of its petroleum on transportation and 50% of our electricity is made from coalⁱ.
- **Lowering greenhouse gas (GHG) emissions.** Emissions from transportation and coal based electricity generation are 71% of the US's annual GHG emissionsⁱⁱ.

The interesting part is how well these technologies work together to address these issues:

“PV’s provide clean electricity to EVs, which in turn reduces our dependence on fossil fuels...and both require less maintenance than the technology they are replacing.”

Now that every major auto manufacturer has announced their plans to bring EVs to market in the next few years, the race is on to figure out the most efficient way to get solar power into your EV's batteries.

Today, the conversion of energy from PV to EV requires an interim conversion step to Alternating Current (AC – which our electrical grid uses) which steals away some of the energy that the PV panels create.



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University of Central Florida's Big Idea

The University of Central Florida's (UCF) School of Electrical Engineering and Computer Science has a better idea...**Skip the conversion to AC!**

While skipping a conversion step sounds simple enough, it's not. Solar panels and EV batteries operate at different voltages so the system needs to be able to convert the voltage in the process. While that doesn't sound too difficult, the hard part is converting many kilowatts of power on a continuous basis without fail.

Drs. Issa Batarseh and John Shen believe they can reduce this 10% conversion loss to about 5% percent with their DC-DC conversion technology.

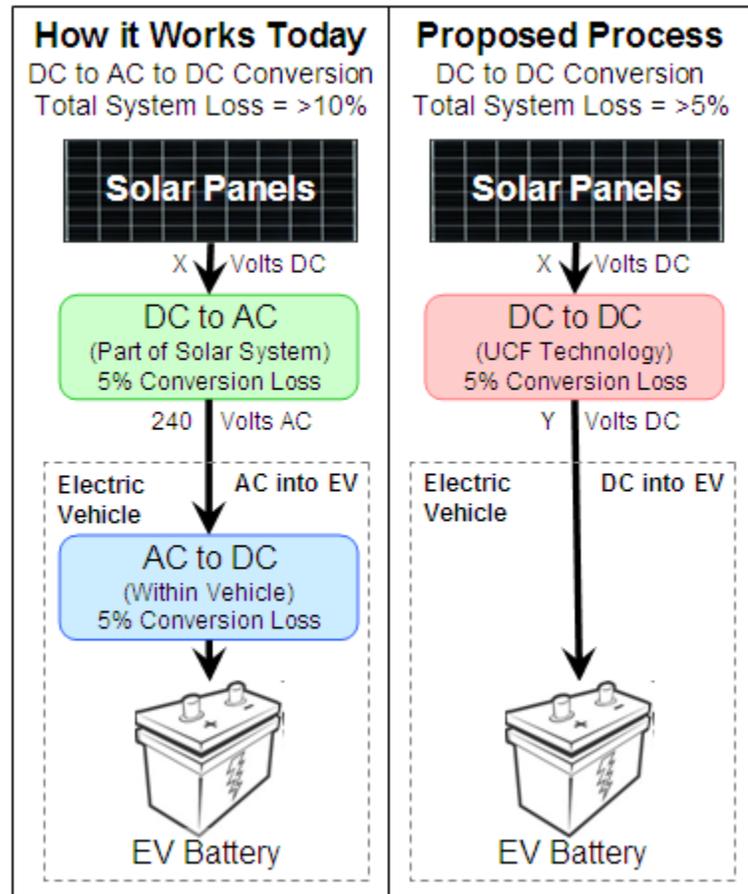
In addition, they have a plan to package this system into a Multi-port design so that it can...

- Send excess power to the grid (AC) if battery charging is complete
- Use power from the grid to charge batteries when solar power isn't sufficient
- Move power from the EV's batteries to the grid. This is called Vehicle to Grid (V2G) and is a promising new energy storage method which will allow an EV to sell stored energy back to the utility using "rules" you give your EV.

This technology is currently under development and being tested on the bench. In order to take this project to the next step, UCF needed a platform to test their technology in the real world....thus the need for the Solar Powered Charging Station.

To pay for this unique real world testing facility, Dr. John Shen and his team at UCF applied for...and won a grant from the Florida Energy Systems Consortium in 2008 to build this project.

To build it, UCF turned to Wharton-Smith, a premier general contractor in Central Florida which has built several major projects and buildings for UCF over the years. Wharton-Smith then selected Matern Professional Engineering for the design and Palmer Electric for the installation of the project.



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The Design

This project had four primary design goals...

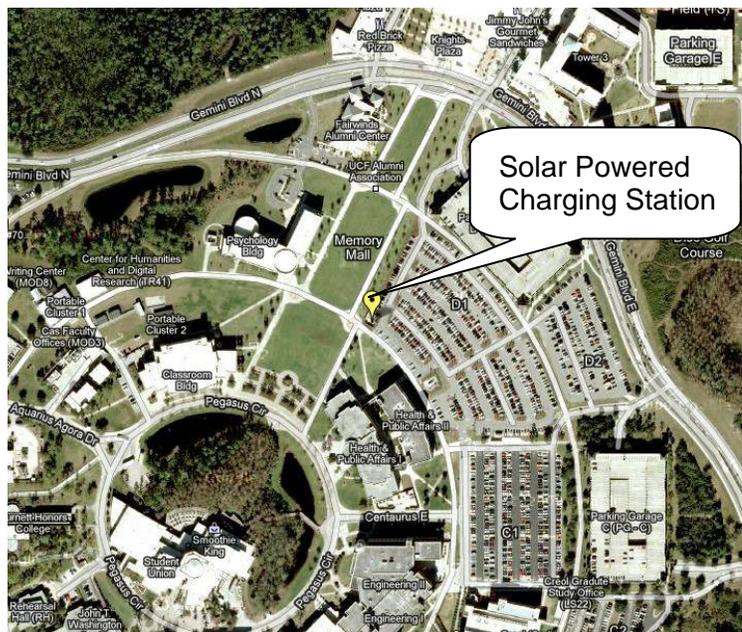
1. **Generate Solar Power.** The 48 solar panels atop the custom built carport structure will generate 10,000 watts peak from the sun.
2. **Charge Electric Vehicles.** The project is wired to charge six vehicles, but only four parking places will be initially outfitted.
3. **Easily Configurable and Accessible for Development.** Cabinets and equipment will allow UCF students to easily test equipment.
4. **Look Great.** The location of the project is on UCF's "Memory Mall", which is a central outdoor area that hosts many outdoor events. It needed to look impressive to reflect UCF's standard for excellence.

Obviously, this was a very special and unique project, as there are very few solar carports or EV charging stations around today that the engineers could use as examples. This meant that the entire project would be built from scratch, including the structure itself.

Design Goal 1: Generate Solar Power

The location and direction of the solar panel array dictate the performance of the system. The closer you can point the panels directly South, the better...but you also want to be close to existing power distribution equipment to lower connection cost. You also want to have a parking lot near it so that it's cheaper to install the EV charging stations. After evaluating several locations at UCF, an area in Parking Lot D1 next to Memory Mall was selected because it was...

- On the corner of an existing parking lot
- Next to an existing power transformer
- Close to the Engineering and Computer Science College
- In a highly visible area to promote its availability and encourage people to purchase an EV
- Allowed the panels to have an SE orientation which enabled the system to generate more power in the morning when students arrive for school



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Here are a few interesting notes about this design goal ...

- The structure is a custom designed, clear anodized aluminum structure designed for winds up to 110 mph
- There are 48 Sanyo 195W (9,360W Total) “Bi-Facial” Solar Panels which can collect an extra 30% more power from light reflecting from under the structure.
- The solar panels are grouped into two arrays, each with four strings of six PV modules.
- Generated solar power is currently grid-tied using two 5,000 watt Xantrex GT5.0 DC-AC Inverters which are 96% efficient.
- The solar array currently generates an average of 50 kWh per day. Since there are very few EVs on the road today, most of this energy goes back into the grid which helps offset the University’s electric bill.
- In case of a safety issue, there are two power shutdown buttons which disconnect the solar array from the grid...which in turn shuts down the solar power Inverters.

Design Goal 2: Charge Electric Vehicles

The orientation of Solar Panel Array is directly in front of six parking spaces, so it’s quite fitting that the project was built to support six parking places. At this time, only four of the spaces are outfitted with simple outlets on an aluminum pedestal. The other two spaces have conduits in place to support a future installation.

Here are a few interesting notes about this design goal ...

- Outlets are currently used to charge PlugIn Hybrids...like this prototype 2011 Ford Escape Hybrid
- UCF plans to run charging tests on existing electric vehicles at UCF (e.g., Neighborhood Electric Vehicles (NEV), Golf Carts, Zenn Motors).
- Future goal is to outfit the outer two parking spaces with new EV charging stations which will be coming out in the second half of 2010. These new stations will have the recently standardized SAE J1772 plug which all US EVs will use as a “filler hose”.
- Since vehicles with lead acid batteries will be charged, it was prudent to install an eye wash station...just in case something went wrong.



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Design Goal 3: Easily Configurable for Development

A large amount of forethought went into the design to make it easy for UCF students to install new technology, measure the system's performance, and reconfigure the system's components based on the testing need. This was challenging because several assumptions had to be made on what students would need to do.

Here are a few interesting notes about this design goal ...

- Large equipment cabinets were chosen so that entire subassemblies could be installed in a dry, clean environment for easy measurement and replacement.
- Wiring from the Solar Panels enter the cabinet in smaller strings (3 panels to a string) so that students have the ability to route smaller amounts of power to their devices under test.
- Several disconnects and measurement points were added along the power path so that measurements will be easy. Wires were labeled so that students can easily see what they are measuring.



AC Side of Cabinet

DC Side of Cabinet

"The project went smoothly from design through completion. During the process, design changes were proposed to better facilitate UCF's future research requirements. The team worked together with UCF to understand the new requirements and find cost effective solutions to meet their needs. That's the benefit of working with an experienced team."

Russell H. Garrison, Project Manager, Wharton-Smith, Inc.

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Design Goal 4: Look Great

Given UCF's standard for excellence and the highly visible location that was selected, there was a fair amount of effort that went into the project to make it look great. The structure and charging pedestals are made of clear anodized aluminum and the equipment cabinets are stainless steel. These materials were chosen to look good today...and 10 years from now...with very low maintenance.



Here are a few interesting notes about this design goal ...

- Not only do the Bi-Facial solar panels look great from underneath the array, they also generate up to 30% more power from sunlight reflecting off the concrete and stainless steel equipment cabinets. See the photo on the title page.
- Preplanning was paramount to ensure that all wiring was concealed and no additional access points would need to be cut into the aluminum structure.
- Wiring from PV panels is routed into the structure, down the columns, into underground conduits, and finally up into the cabinets...it is a very clean installation.

"It was great to have a partner like Palmer in the construction of the project. They realized that this project was an opportunity to create a unique and inspiring installation that provides a working demonstration of a non-fossil fuel based transportation infrastructure. They truly understood the location and prominence of the installation as well as the importance of an exceedingly clean installation."

Adrian Baus, Vice President & Lead Project Engineer, Matern Professional Engineering

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Conclusion

On February 10, 2010, the switch was thrown...and the Solar Charging Station started converting the sun's energy into electricity which flowed into the electrical grid. A few weeks later on March 2nd, the system charged its first car-of-the-future – a prototype 2011 Ford Escape Plug-In Hybrid. This car was the center of an event that showcased a partnership between Ford & Progress Energy to demonstrate the benefits of electric vehicles and intelligent ways they can be charged.

This project shows how a single investment can have three significant long term benefits:

- Generates 50 kWh of clean energy each day...which helps reduce UCF's electric bill if no cars are being charged
- Charges up to four electric vehicles today...or six in the future
- Enables UCF to develop new technology which makes the charging of electric vehicles more efficient

Building a unique project like this from scratch takes a special team of people that can understand the requirements, create a design that exceeds the client's goals, and deliver the project on time and within budget.

If you would like to see this state-of-the-art project in action, head to parking lot D1 at the University of Central Florida near Orlando, Florida. Bring your Electric Vehicle if you've got one...you and your car will get a charge out of your visit!



Dr. John Shen and his team of Graduate Students who initiated the project

"Overall, I'm very happy with the project - the College of Engineering and Computer Science now has a state-of-the-art test bed to validate our research in power conversion technology. I'd like to recognize Chris Kennedy, UCF's Project Manager for going beyond the call of duty, Matern Professional Engineering for their attention to detail, and Palmer Electric for their fabulous execution."

John Shen, PhD, Professor and Project Initiator, School of Electrical Engineering and Computer Science, University of Central Florida

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Project Team

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Grant Source	Florida Energy Systems Consortium
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Electrical Contractor	Palmer-Electric. (407) 646-8700 Project Manager: Steve Conenna Project Foreman: Jon McLendon, Apprentice: Sean Harris
Structure	Perfection Architectural Systems, Inc. Robert Banyas, Jim Schinina, and Carlos Ramirez
Case Study Author	Mark Thomason
Photo Credits	Don Brouillard, Jim Siegel

References

ⁱ US Department of Energy, Annual Energy Outlook 2009.

ⁱⁱ Raupach, M.R. *et al.* (2007). "[Global and regional drivers of accelerating CO2 emissions](#)".