Solar Recharge Station for UGArden's Electric Vehicle

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Introduction:

Fossil fuels are scarce, and it is becoming increasingly difficult to meet the everyday demand for fuel in modern society. As gas prices rise, people are becoming concerned about transportation once oil either runs out or becomes too expensive to attain. The leading alternative to gasoline fueled vehicles is electric powered vehicles. Although electric vehicles are an alternative to gasoline fueled vehicles, they do not address the issue of having to burn fossil fuels to create the electricity needed to fuel the vehicles. One of the leading alternatives to burning fossil fuels for electricity is the use of solar energy. Some solar powered vehicles have been produced, but they are very expensive and concerns exist about the lifespan of the panels in comparison to the lifespan of the vehicle. The design of a solar recharge station eliminates all fossil fuels from the process of powering vehicles.

Acknowledgements:

We would like to give special thanks to the following companies and individuals for their contributions to this project: the College of Engineering, Dale Threadgill, the Office of Sustainability, Kevin Kirsche, MAGE Solar, UGArden, David Berle, and Drew Bowen.

Problem Statement:

UGArden needs an efficient, sustainable, and cost effective way to charge the electric vehicle used to bring families food and for small tasks around the garden.

Data Collection:

This project required data collection of many different types. The first step was to assess the site for the solar recharge station. This included collecting solar data on the specific location as well as meteorological data. This was done using PVSyst.

The next stage of data collection was on the car. This included data on the vehicle's power requirements, recharge time required, and estimated use of the vehicle.
Analysis was also done on different solar panel and inverter options to help choose the solar panel and inverter setup that would be the most efficient for this specific project. There were also cost analysis data that were collected and analyzed to ensure that the project stayed within budget.

Data were also collected for the site where the panels are to be located. The wind load was determined to be 90 mph[1]. The snow load was determined to be 5 lbs/ft2[2]. After inspection of the site the wind exposure category was determined to be Exposure C. This comprises of "open terrain with scattered obstructions having heights generally less than 30 feet. This category includes flat open country, grasslands, and all water surfaces in hurricane prone regions."[1] The occupancy code for the building was determined to be Occupancy Category II. This was determined through visual inspection of the building.

However, this design parameter no longer applied after the structural analysis of the building where the solar panels were initially going to be placed.

The initial idea for the solar panels was to have them mounted to the roof of an existing structure. However, after running tests using STADD Pro on the structure a number of beams could not meet the load. A large number of the beams failed under the applied forces from the panels. Due to the issues associated with mounting the panels on the roof, it was determined that the solar panels should be mounted on poles in the ground.

Expenses:

This project was awarded $5,000 from the Office of Sustainability and $3,000 from the College of Engineering. This totals to $8,000. The spending of the money is broken down into several categories (see Table 1).

Table 1: Costs and Expenses

	Cost
Micro-inverters	$1,500
8 Solar Panels	$2,400
Donated Panels	-$2,400
Pole Mounts	$1800
Meter Socket and Software	$800
Cabling	$500
Signage	$200
Labor	$4,415
Total	**$9,215**

This cost break-down is an estimate only, and does not represent final costs. Included in the estimate is the cost to update the current building's electrical tie-in.

Resources Conserved:

This design meets the criteria of fueling a vehicle completely without the use of fossil fuels. Considering the amount of carbon dioxide released by burning coal for electricity generation, the carbon offset calculated for this station is 5,443 lbs of carbon dioxide per year[2]. The final design will supply well over the necessary amount of energy to power the car. The excess energy produced will support the electrical needs of the building on the site and possibly a new walk-in freezer that has been proposed by UGArden to preserve the food produced by the garden.

Partnerships Formed:

Through this project many partnerships were formed. We established a partnership with Mage Solar, who donated two of the solar panels to our project. We have also formed a partnership with Drew Bowen, who will be the contractor responsible for the construction of the solar station. Lastly, we formed a partnership with UGArden's who will be benefitting from the solar station by being able to charge their electric vehicle free of charge and will also have enough excess power to install a walk-in cooler, if needed for the produce produced at the garden.

Educational Benefit/ Courses Engaged:

This project included simple calculations such as amount of energy used by the electric vehicle, 50% over engineering calculations, and carbon offset calculations. There were also more complicated aspects to the project. A lot of AutoCAD was needed throughout the design process. Learning the intricacy of AutoCAD took some time but overall was beneficial.

Another education benefit from the project was learning the social aspect and all the paperwork involved. At times it could be frustrating but it was an important lesson to learn. Even a small solar project has multiple stakeholders with different views and needs.

However one of the most beneficial learning experiences from this project was the team building skills learnt throughout the duration of the project. As a team we were able to grow and identify individual strengths to help ease the process. Throughout the progression of the project, our team progressed as well. We were able to easily divide up tasks and have individual responsibilities. We learnt the importance of communication between team members and effective ways to communicate such as group meetings, emails, DropBox, and Google Docs.

Return on Investment:

Based on output estimates created through design software and usage estimates provided by the end user, this project is estimated to have a financial break-even point of 14 years when on the buy-back program. The project is not currently on the buy-back program. Through further research about the buy-back program it was determined that it was not beneficial for such a small-scale project. However, if the project were to expand and obtain a position on the waiting list for the buy-back program, the recharge station does have an opportunity to be financially profitable. Another return on investment that should also be considered, although it's not a monetary component, is the carbon offset. The project helps the University of Georgia toward achieving its sustainability goals and this can also be considered a return on investment.

Photos & Figures:

Figure 1: Green Life Expo Display Board

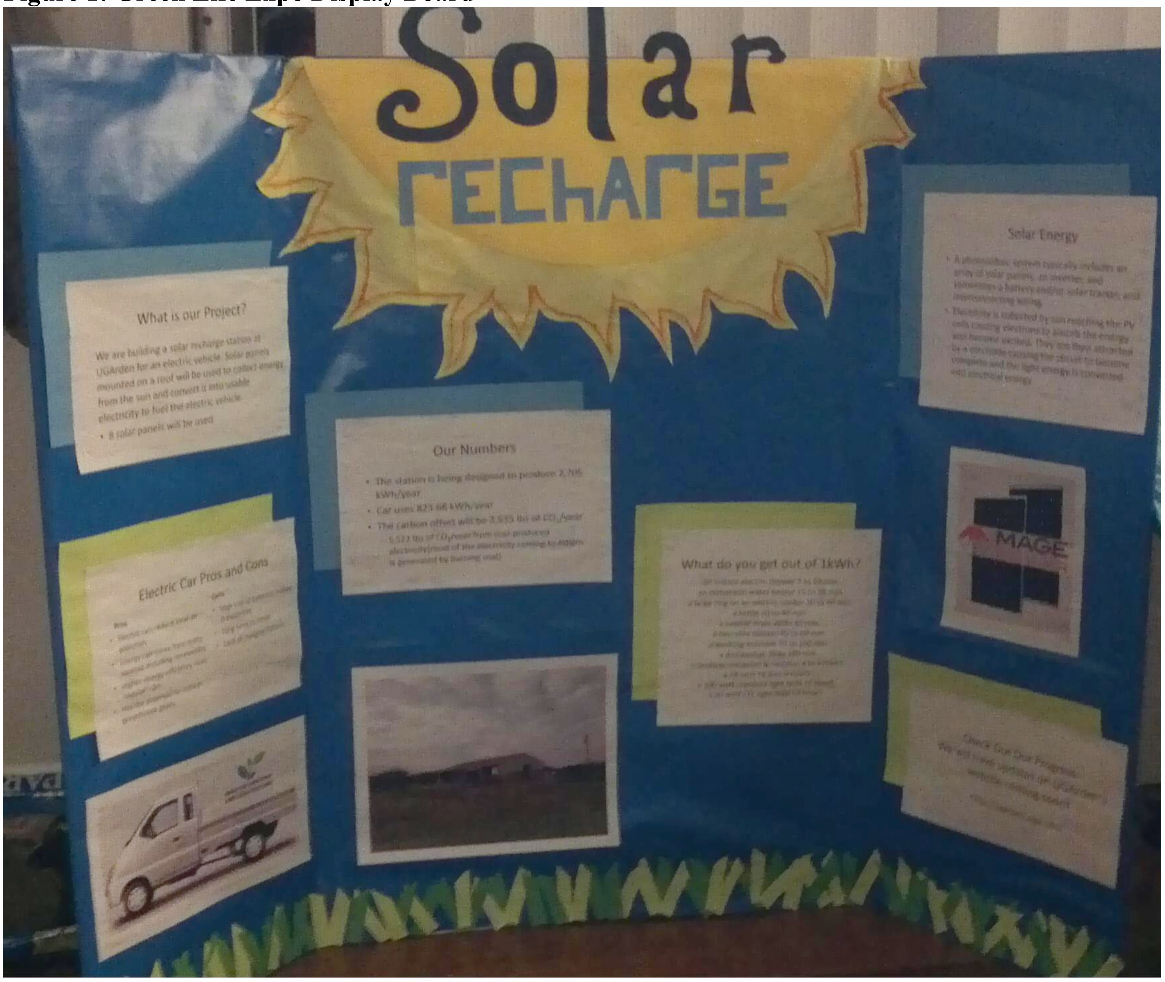


Figure 2: Structural Detail inclduing Pole Set Dimensions and Junction Box Mounting Detail

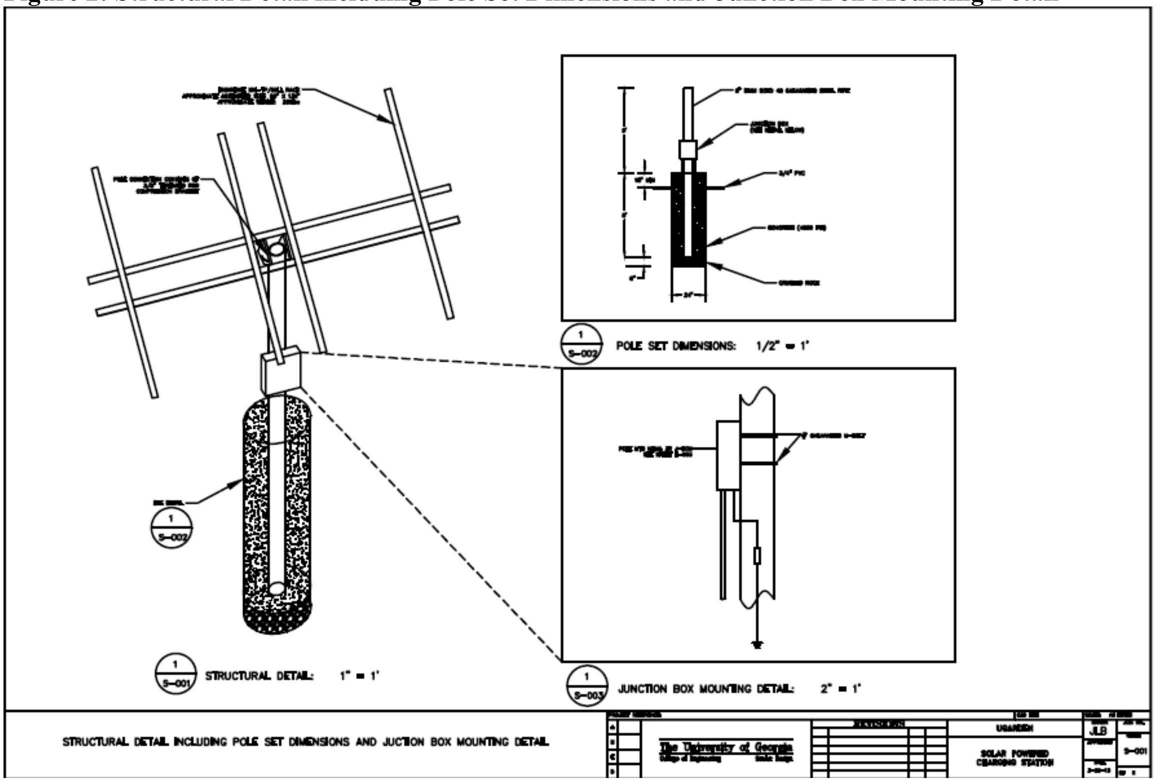


Figure 3: Pole Installation Dimensions and Direct Burial Detail

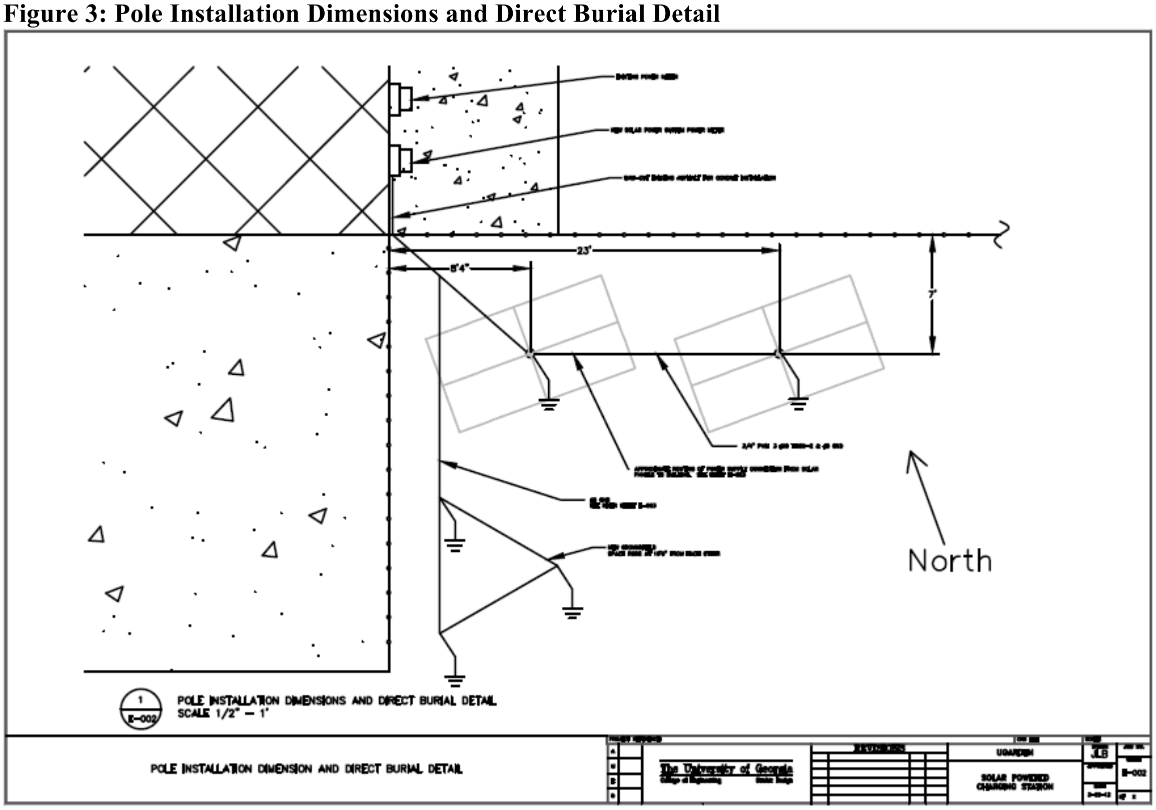


Figure 4: Single Line Diagram

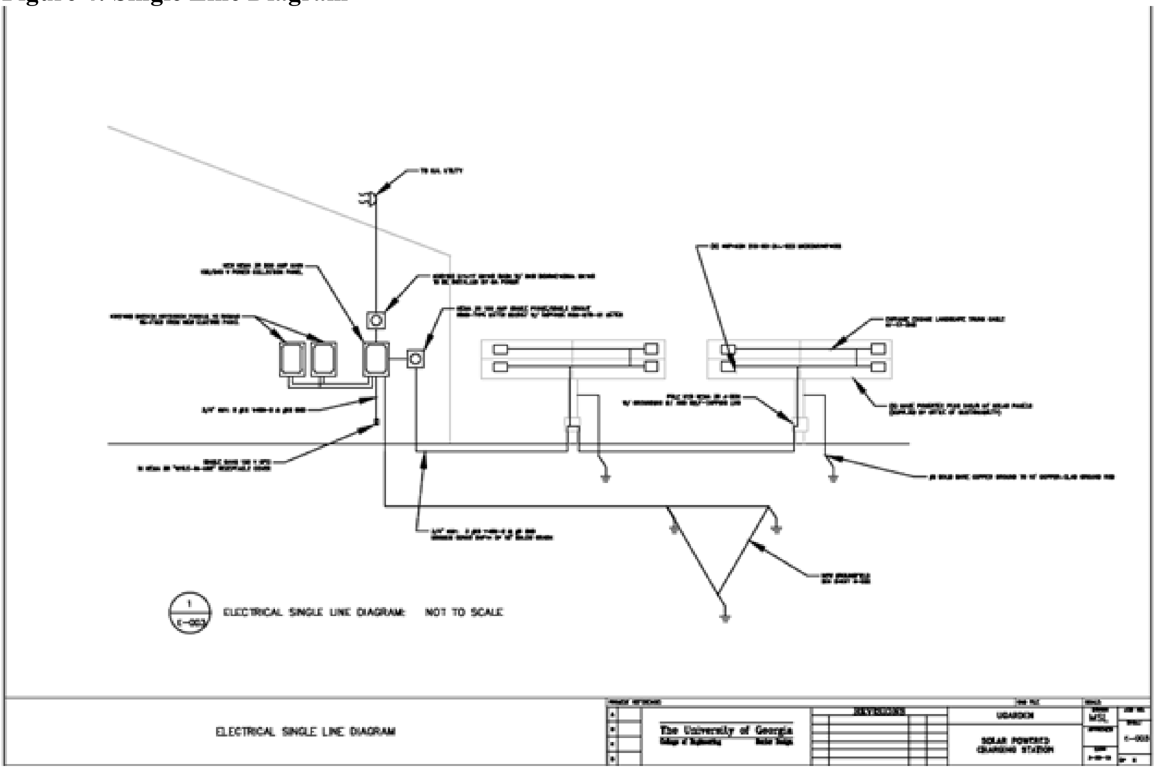
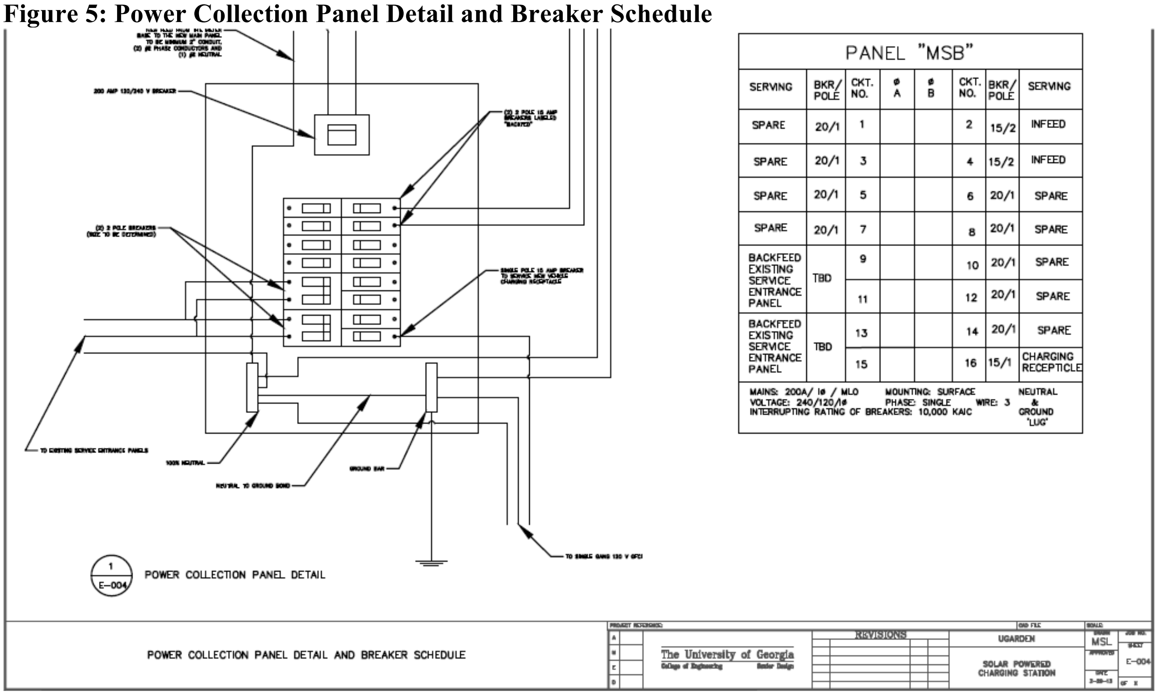


Figure 5: Power Collection Panel Detail and Breaker Schedule



PANEL "MSB"

SERVING	BKR/POLE	CKT. NO.	φ A	φ B	CKT. NO.	BKR/POLE	SERVING
SPARE	20/1	1			2	15/2	INFEED
SPARE	20/1	3			4	15/2	INFEED
SPARE	20/1	5			6	20/1	SPARE
SPARE	20/1	7			8	20/1	SPARE
BACKFEED EXISTING SERVICE ENTRANCE PANEL	TBD	9			10	20/1	SPARE
		11			12	20/1	SPARE
BACKFEED EXISTING SERVICE ENTRANCE PANEL	TBD	13			14	20/1	SPARE
		15			16	15/1	CHARGING RECEPTICLE

MAINS: 200A/ 1φ / MLO MOUNTING: SURFACE NEUTRAL & GROUND 'LUG'
VOLTAGE: 240/120/1φ PHASE: SINGLE WIRE: 3
INTERRUPTING RATING OF BREAKERS: 10,000 KAIC

References:

[1]Applied Technology Council. "Wind Speed Web Site: Windspeed by Location." Web 02 Feb 2013. <www.atcouncil.org>.

[2]"Frequently Asked Questions." U.S. Energy Information Administration. N.p., 12 Feb. 2013. Web. 04 May 2013. <http://www.eia.gov/tools/faqs/faq.cfm?id=74>.

[3]"Ground Snow Loads Pg for the United States (lb/ft2)"; Web. 02 Feb 2013. <www.publicecodes.cyberregs.com/icod/irc/2003/icod_irc_2003_sec001.htm>