Abstract
The concept of a solar electric vehicle charging station is a relatively recent concept, mostly because of design limitations in past Photovoltaic (PV) systems. Around the turn of the century, there have been a number of companies planning and implementing such designs. In 2009, Chicago revealed its first solar powered Electric Vehicle (EV) charging station, and as far back as 1998, the city of Santa Monica moved to authorize a 31 kW solar carport for the Civic Auditorium, which could easily be used to charge EVs. The need for such stations is underscored by an Electrification Coalition report in 2010 that indicates, "75 percent of light-duty vehicle miles traveled" could be electric by 2040.

Goal setting for EV use is a step in the right direction for sustainability in the United States, but to meet these goals would clearly require the implementation of an extensive network of EV charging stations, much like the 117,908 gasoline stations powering current gas-powered vehicles. In that spirit, ECOtality's October 2010 announcement of a partnership with BP Products North America to test their Blink EV DC fast chargers at 45 locations is promising. Quick-charging stations are essential to the future of EV accessibility to the greater public.

Project Proposal and Anticipated Benefits
We propose to meet the objectives of the "Green Island" RFP by demonstrating a utility cart recharging station using 100% clean renewable energy for use in daily operations by the UC San Diego Transportation Services Department. By placing solar panels on an aesthetically pleasing structural canopy in a centralized, high-visibility location, we will make renewable energy available for recharging batteries of all types, in places where electricity is needed most; where none exists now.

UCSD central campus open spaces are a series of small parks between classroom buildings. These are locations where people congregate and co-incidentally, where service vehicles are frequently parked nearby. (See Figure 1) A Green Island power station can generate power from the sun even on a cloudy day. For the students who visit the Green Island, can fill the batteries in their portable electronic devices at outlets at the perimeter of the structure and beyond. This is a practical, useful and unique extension of the Green Island concept. We feel our team and our support groups can make this happen.

Figure 1: Utility vehicles surround the grassy park near Warren College, a popular hangout on sunny afternoons.

UCSD has already done the hard work; they've replaced many of their gas engine utility vehicles with a fleet of plug-in electric utility vehicles. We want to make a good system even better. An off-grid renewable energy charging system has a value to the university by extending the range of its service fleet, allowing drivers the ability to accomplish more before having to return to the central charging location. (Figure 2)

Figure 2: At the Gilman parking structure, at the SE corner of central campus, two electric utility vehicles take a break from active duty.

With over one hundred EVs and PHEVs at UCSD, many campus vehicles sit idle at indoor charging stations. Green Island charging stations could improve usage patterns by letting vehicles recharge nearer to areas where they are used, cutting unnecessary 'logistical' return trips, and possibly freeing parking spaces for other uses.

We propose to design and test a system that will make university investments last longer, by preventing battery failure through over-discharge. This approach would maintain a higher average state of charge during round-trip transit, when the vehicle is away from the Transportation Department and Facilities Management recharging locations. When batteries under load fall to deep depths of discharge, (See Figure 3) it is crucial to recharge without undue delay. Drivers would be informed of Green Island remote location charging for emergencies.

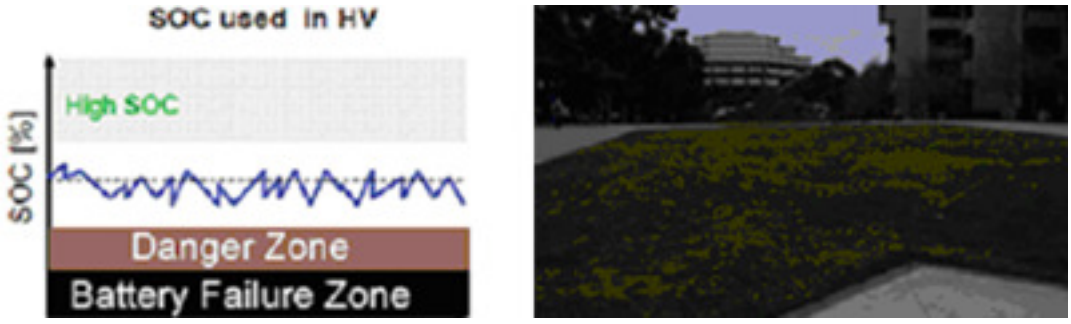

Figure 3 – Hybrid Vehicles have reliable long-lasting batteries because the system is designed to keep the batteries in the safe State-of-Charge area (Blue line). The green island in a convenient central park location, like above, can put batteries back into the safe zone for the return trip.

EVs are often driven to deep depths of discharge, which shortens battery life and decreases efficiency. A Green Island can recharge before the return trip and avoid the danger zone. Solar PV for EVs may result in fewer towing maintenance calls and cost savings for the university – we would like to work with UCSD to determine the cost effect on servicing. We propose to examine the effect on vehicle performance and determine if there are any changes to driver behavior and pattern. If there is a cost savings, ESW, SunEdison and participating donor organizations will be acknowledged for the achievement.

When a Green Island utility vehicle returns to the Transportation Services Facilities, it will need less power to recharge, which will lower demand for imported power from the local municipal utility grid, thereby helping UCSD to come one step closer to realizing its goal of 90% self-generation by 2011. Solar PV charging for vehicles benefits all citizens by cleaning the air, reducing emissions from UCSD and SDG&E's centralized power generation facilities. Recharging batteries directly from the sun increases the overall efficiency of the vehicle and charging infrastructure, avoiding the long-range transmission inefficiencies and infrastructure costs involved in maintaining and expanding utility transmission for the growing market of electric vehicles. A project funded by ESW and SunEdison will serve as a platform to help educate the public about environmental policy and projects so they can participate in the process.

Our approach will put solar power at eye-level, and within arms reach, where the students, faculty and visitors can see it in use. Successful completion of this project will require teamwork among university students and co-operation with university officials. Our efforts will be rewarded with increased exposure for the donor and participating organizations, for the university, and for the students.

Figure 4 – a lightweight steel frame Envision Solar 2.4 kW off-grid PV system charging two NEVs at an amusement park. An Envision 1.4kW Solar Tree is a great shade-maker.

Daytime solar PV charging means less daytime plugging into the grid, so drivers can have increased productivity and vehicles aren't trapped at home base.

A simple and fun project with an obtainable goal will make it easier for a new organization to bring together a community of Solar PV, EV and environmental enthusiasts. They'll have a great sense of pride and accomplishment when they see the Green Island utility vehicle on campus in use. Students will friend the ESW for the

privilege of recharging their laptops in additional convenient locations on campus. The contacts that we make and the bonds that are formed, will serve as the foundation for more student participation and membership activities for years to come.

The 'Green Island' EV charging is a relatively new concept but there are many component products available today. Off-vehicle charging in remote locations is a safe way to re-fill away from the home or office. Standard 120v AC service is available through a variety of off-the-shelf products, and at reasonable prices, like this 200 watt wall or roof mounted SmartBox solar panel from Clarion Power. (Figure 5 - "SmartBox"). The $800 SmartBox is compatible with any welded steel or extruded aluminum frame PV structure. Smart Box solar panels are modular and output standard household current. Because the inverter is included, passers-by can plug-in directly to a solar panel.

The UCSD has an Advanced Zero Emission Vehicle Project already underway to eliminate greenhouse gases and air pollutants by using secure, domestic, renewable energy resources to charge a variety of vehicles. (**Figure 6: NREL Solar Tree**) The US Department of Energy and the California Energy Commission have provided $2.5M funding for UCSD to develop strategies for mitigating the negative impacts from high penetrations of solar systems on a distribution grid. In keeping with the University's architectural style, we plan to heed the lessons already learned and build something similar in aesthetics, but more versatile in function. While the costs of recreating a system as large as UCSD's established charging stations are beyond the scope of the current request for proposal, we feel an off-vehicle solar PV charging system for utility vehicles and accessory convenience charging is within the RFP guidelines and meets the goals and spirit of the Green Island concept.

Summary

The Solar Charging Station is a perfect fit for a Green Island Project. The system's energy source will use solar panels for a variety of off-grid applications, including charging electric utility cart batteries and charging students' laptops. The change of this energy resource to renewable solar energy is important for the overall resource management. As part of the project we plan to study the use of the carts during the day (the energy demand), in relation to the available solar energy resource, which should be useful for any future solar projects or projects involving the management of the UCSD cart fleet.

Furthermore, this project is a perfect fit for the mission, vision and values of ESW and SunEdison. Our project utilizes the most plentiful and sustainable form of energy in existence. The application of charging student laptops is a convenience that makes life easier. Our project builds awareness about using technology and creativity to solve global concerns.

We recognize that our project is a small part of a larger struggle for sustainability and innovation. We will engage the local UCSD community and we hope that our project will contribute to a sustainable future. We believe both this project and these ideals fall under the shared values of SunEdison and ESW: practical action, environmental accountability, partnerships & collaboration, innovation, people and relentless passion.

Supplemental

Budget
All figures are estimates. Final product selections and component configuration is will be determined in a trade-off feasibility study. Additional funding for equipment purchases and donated equipment may be available from supporting groups.

Total Budget - $9900

- Marketing materials to recruit the project team / student support: up to $200
- Solar panels: Modular systems, as many as needed, up to $4,000
- Converters, Battery management system, charge controller, inverters, connectors, containers and electrical supplies – $1,500
- Batteries: Individual cells, as many as needed, 5-6 kW Li-Ion or equivalent Lead-Acid - up to $2,200
- Structural Materials (Aluminum extrusions, frame) - $2,000

Federal, State, and local tax rebates and incentives are available to offset some of the costs, so that the actual budget may be substantially lower. Final design and commitments to equipment purchases will not exceed $9,900.

Timeline / Milestones
The following estimates are based upon concurrent milestone progress from existing support groups and new member student support. We propose a divide-and-conquer approach to assemble teams based upon skills and experiences, so that independent tasks can advance at the same time. The total project duration therefore is shorter than the sum of the estimates.

We feel the entire project could be completed within one year, assuming a moderate level of student interest. Some tasks take less than a month, but for the purposes of this request we round up to the nearest month to allow for unforeseen circumstances. One of the biggest variables is student scheduling. Another is university participation and approval process. Considering the recent member and volunteer activity for ASES and the prompt and enthusiastic responses from UCSD officials, we are confident. We are flexible in our

product design and will strive to remove and limit undue complexity. We plan to provide ESW with regular progress reports.

Total project duration = 7 - 10 months.

1. Perform a feasibility study product matrix of available products that satisfy the criteria of Green Island Concept. (1 Month)
2. Announce the project through marketing materials, campus news, and internet sites to recruit new member student and community support. (1 Month)
3. Design a solar tree with products chosen from the data in Step 1. (1 Month)
4. Identify potential Green Island sites based upon driving patterns, usage and availability of parks in high visibility areas on Campus. (1 Month)
5. Gather feedback from university officials regarding location choices and design. (1 Month)
6. Choose location from list of UCSD approved locations. (1 Month)
7. Build and test the design, monitor for charging and use data. (2 Months)
8. Review and approve compliance with University guidelines for safety and use. (1 Month)
9. Install at the approved location, test and monitor data. (1 Month*)
10. Deliver metrics, data analysis and project review to ESW. (1 Month)

*With permission from university officials, the test design in Step 7 may be built on-site at the approved location, and in that case Step 9 would be unnecessary.

Sources

http://energystrategy.calit2.net/ (UCSD's "The Endgame")
http://www.businesswire.com/news/google/20090408005380/en
http://www01.smgov.net/cityclerk/council/agendas/1998/s1998072806-F.html
http://electrificationcoalition.org/reports/EC-Fleet-Roadmap-screen.pdf
http://factfinder.census.gov/servlet/IBQTable?_bm=y&-geo_id=&-fds_name=EC0700A1&-ds_name=EC0744I1&-_lang=en
http://www.ecotality.com/newsletter/10132010_BP_Blink_DC_Fast_Charger.html
http://www.envisionsolar.com/

Letters of Support

See attached letters from Jan, Kurt, Charlie, Dave, SRC, ASES/SDRES, etc…